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HIGH VOLTAGE POWER TRANSMISSION.

THE conversion of the energy of a waterfall into electrical energy, and its transmission to a distant point, there to be used for lighting and motive power, is a subject which has attracted much attention of late years; and although the installations which are in daily use for the transmission of electrical energy to considerable distances are not so numerous as some enthusiasts expected they would be, after the Frankfort-Lauffen experiment, yet considerable progress has been made, for plants working at 10,000 to 20,000 volts, and transmitting energy to distances of 20 to 30 miles, are in regular use, and it is even possible to point to one plant working at 40,000 volts and transmitting energy a distance of 35 miles.

It is not in England, nor, indeed, in Europe, that we can find many examples of long-distance transmission, and the reason is not far to seek, as in most European countries it is possible to find customers for electrical energy within a comparatively short distance of any place where it will pay to put down a generating station. In America the case is different, and it is there that most of the long-distance transmission plants are at work; though even there the distances are moderate compared with the 108 miles from Lauffen to Frankfort. In India, New Zealand, Egypt, and South Africa there is, as Prof. Forbes told us in his recent Society of Arts paper, a good field for long-distance transmission, especially in the gold-mining districts, where long prices can be obtained and power is required continuously day and night; and it will be remembered that in this paper Prof. Forbes set himself the task of showing that, under such conditions, transmission over 200 miles or more, with a voltage not exceeding 20,000 volts, was commercially possible.

In the United States the Westinghouse Company has, as is well known, taken a prominent position in the installing of transmission plants, and in connection with this branch of its business, a number of experiments have been made, not only in the laboratory or on artificial lines, but also on lines in actual daily use and subject to the varying conditions met with in practical work. The results of these investigations have been communicated to the American Institute of Electrical Engineers by Mr. C. F. Scott in an interesting paper, from which we learn that it is neither the transformer nor the insulator which is likely to set a limit to the voltage that can be employed, but that this limit will be fixed by the loss of power through the direct leakage from wire to wire through the air; that is, that for any given transmission there will be a certain economical voltage, as any increase above this will increase the loss by leakage from wire to wire more than it will decrease the loss in the wire by the reduction of the current to be delivered at the far end of the line. The statement that the transformer is not the factor which sets a limit to the voltage must be made with the reservation that its output must be large, say, 200 kilowatts or more, as in smaller transformers the insulation requires so much room that they cannot be built economically. This same question of output affects the commercial limit in other ways also; for instance, the charging current to the line will be practically the same

whether the wire can transmit 1,000 or 100 horse-power, and a charging current which would be of no great importance in the former case, might in the latter require generating apparatus twice as large as that necessary for the actual power. Again, a loss from wire to wire, which would be a small percentage for the large output, would be a large one for the small output, and, of course, the cost of poles, insulators, and line, and of their maintenance will be but little less for the small output than for the large.

With regard to insulators, Mr. Scott says that he can see no advantage that porcelain has over glass, unless it be that of superior mechanical strength, which he considers of small importance, as almost all breakages occur from the insulators being used as targets, and a rifle ball will smash one as easily as the other; besides which, porcelain offers a better mark than glass. We are told that great trouble has been experienced through inequalities in the porcelain, and the impossibility of deciding whether an insulator was sound or not, except by the application to it of a high pressure test. This difficulty does not occur with glass insulators, which are cheaper and lighter, and so far as can be judged from the tests, in no way inferior to porcelain in non-hygroscopic properties. Tests were made on some double petticoat glass insulators $5\frac{1}{2}$ inches diameter and 5 inches high, one wire being run along the tops of the insulators, and another connecting the pins, and with 25,000 volts between these wires, which corresponds with 50,000 volts between a pair of transmission wires, the loss was only 2 watts per insulator. Comparative tests were also made on the lines of the Telluride Company, which are over two miles in length, and are carried on 62 poles, each fitted with three cross-arms, two of which were each fitted with two glass insulators, whilst the third was fitted with two porcelain insulators. These latter were double petticoat, $5\frac{7}{8}$ inches diameter by $4\frac{1}{16}$ inches high; one of the glass insulators was of the dimensions named above, and the other was a triple petticoat, $4\frac{1}{4}$ inches diameter and $3\frac{1}{2}$ inches high. Tests made under different conditions of weather showed in all cases that there was no appreciable difference in the leakage over the three types of insulator, and that in all cases, as soon as very high voltages were employed, the loss from the insulators was insignificant when compared with that due to leakage through air from wire to wire. As showing what insulators of the sizes named can be used for, it is interesting to note that this line at Telluride was run continuously for 37 days at 50,000 volts, and that at Provo, where the power for the De Lamar mines and mills has for some time been obtained by a 35-mile transmission at 40,000 volts, the glass insulators are 7 inches diameter, by $5\frac{1}{2}$ inches high.

The losses by air leakage from wire to wire which have been found to be so important were the subject of tests made at Telluride, and also on artificial lines. At Telluride a series of measurements was made to determine the connection between this loss and the distance between the wires, which was made successively 15, 22, 35 and 52 inches; and the results are shown in the paper by curves giving the loss as ordinates and the voltage as abscissæ. These curves in each case begin with a straight line rising very slowly with increased voltage up a certain point depending on the distance between wires, and then bend up rapidly and follow a line which makes but a small angle with the vertical. For comparison a dummy line, only 60 feet long, but with the same number of insulators, was tested, and it was found that the losses were represented by a straight line rising slowly, and practically identical with the first part of the curve obtained on the long line, but with the dummy line there was no bend upwards corresponding to that found in the curve of the long line. It was, therefore, concluded that the loss below the critical point where the bend commences was due to the insulators, and that the air leakage loss only became appreciable after reaching this point, which corresponded with a pressure of about 40,000 volts when the wires were 15 inches apart, and 50,000 volts when they were 52 inches apart. The rapid increase of the loss after passing the critical point is shown by the fact that, whereas it was only about 150 watts at 40,000 and 50,000 volts respectively at these two distances, it had increased to 3,000 watts at 48,000 and 59,000 volts. When it is remembered that the line on which these tests were made is only a little over two miles long, it will be seen how important these losses may become on a really long line. Mr. Scott's tests show that the loss between wires was not affected by any atmospheric conditions except precipitation, but he warns us that this must only be taken to apply to conditions such as existed at Telluride, where the air and moisture in it are practically pure; and that near large towns the loss would undoubtedly be much greater, owing to the impurities which would be found both in solution in the moisture of the atmosphere and in suspension.

Experiments were also made at different frequencies and with different wave forms, from which it was concluded that a sine wave was the best that could be used, and that the losses did not differ appreciably with different frequencies. The general conclusion arrived at by Mr. Scott is that 40,000 volts may be safely used in climates where the air and precipitated moisture are practically pure, as with any ordinarily good wave form 40,000 volts comes well below the bend in the curve of losses between wires, even under the worst weather conditions; and that under favourable conditions 50,000 to 60,000 volts might be employed for distances up to 150 or 200 miles without any new or modified methods of transmission being required. At the same time he draws attention to the fact that dangers and difficulties attend the use of these high voltages, and accidents can only be avoided and success insured by employing the utmost care and excellence of workmanship and design. There are difficulties enough in handling 15,000 to 20,000 volts, and as the pressure is raised the liability to trouble increases at an alarming rate, so that although pressures up to 40,000 volts have been and are in regular use, his advice is that they should never be used where it is possible to avoid doing so.

Earth Resistance.

At the last meeting of the Institution of Electrical Engineers, a question was raised by Mr. Sinclair as to the resistance of an "earth." He stated that it was more difficult to get "good earth" for short lines than for long ones. If this is, indeed, the case, it is to be hoped that Mr. Sinclair will communicate some further information on the subject, and condescend to a few figures to give a reason for the faith that is in him. It is, of course, generally true, as we were reminded by Dr. Lodge, that the resistance between two metallic plates buried in the earth is independent of the distance between them, and that this constant resistance is more significant for a short line than for a long one. Mr. Sinclair must have known that. The resistance depends primarily upon the conductivity of the earth immediately in contact with the plates, *i.e.*, upon the effective area of the plates. If the lines of flow are approximately straight, the resistance is inversely proportional to the square root of that area. Moreover, the resistance is proportional to the average specific resistance of the separating medium, so that a yard or two of Sahara might easily out-resistance a hundred miles of London clay. If Mr. Sinclair's observations refer to plates of equal effective area, buried in all cases in a medium of the same average specific resistance, they are very remarkable, and deserve to be repeated. The resistance of earth plates is generally measured by taking three of them, and measuring the resistance two and two all round. In solving the three consequent equations, it sometimes happens that one or two of the plates appear with "negative resistance," explained by the back E.M.Fs. of polarisation. When such cases arise they should be a warning to students as to the restricted meaning of "resistance," and above all things they should beware how Ohm's law is applied. In practical telegraphy, at any rate as regards England, the water-pipes are generally available, and the so-called "earth resistance" is a very small quantity. Trouble such as that indicated by Mr. Sinclair is generally due not so much to the "earth" having a high resistance, as to the fluctuation of the earth resistance, with capacity in circuit. The cure and the prevention is to make good joints. Mother Earth's all right.

THE MAGNETIC PROPERTIES OF TEMPERED STEELS.

(*Continued from page* 42.)

General Results.—The principal results of the whole investigation are collected in Table I. The first column gives the description of steel with the percentage of the particular constituent whose effect is being studied. The percentage of carbon is given in the second column, and the temperature at which the steel was quenched in the third. In the fourth is the coercivity, a quantity characteristic of the material, and independent of the form of the magnet. The residual magnetism depends largely on the form of the magnet, as well as on its material, since it is affected by the demagnetising action of free polarity. It is, consequently, tabulated in different columns, according to the particular form. A comparison of the figures of two magnets of the same material, but of different shapes, *e.g.*, 625 for a closed ring, and 30 for a bar, each made of the same material, the first tabulated, shows the importance of this distinction.

Tungsten Steels.—Mme. Curie comments at great length on the numerous results of this table, but her remarks on the tungsten and molybdenum steels, which are of most importance to magnet makers, are alone referred to here. The best tungsten steels for magnets are those of Assailly (V_3 . H_c = 68 . I_1 = 500), of Chatillon et Commentry (*b* . H_c = 69 . I_1 = 540), of Boehler (special very hard, H_c = 74 . I_1 = 530), of Allevard (H_c = 72 . I_1 = 560).

Boreas Steel.—The Boreas brand of Boehler steel when hardened, has exceptional properties, and might be of great use. Of the first four steels Mme. Curie remarks:—"The Boehler steel gives very different results with different conditions of hardening. Long heating before quenching destroys its magnetic qualities, and bars of this steel sometimes break after hardening. The Allevard steel is less susceptible of injury by heating, but the bars are also liable to

Table I.—Magnetic Properties of Steel Bars of Different Compositions.

Name of foundry.		C %	T	H_c	I_1	I_2	I_3	I_4	I′
Carbon steels ...	Firminy	·06	1,000	3 4	30	...	...	...	625
		·20	850	11	120	...	...	...	770
		·49	770	23	220	...	...	...	835
		·84	770	53	420	...	480	580	640
		1·21	770	60	460	...	...	...	645
	Boehler, Styria ... ... Mild	·70	800	49	420	...	...	...	...
	Medium hard ...	·96	800	56	420	...	...	...	...
	High tensile strength	·99	800	55	410	...	...	...	...
	Harder	1·17	800	63	460	...	...	...	...
		1·13	850	65	420	...	...	...	...
	Unieux	·75	770	51	410	...	...	...	...
		·80	770	53	420	...	...	...	...
		·83	770	56	440	...	...	...	...
		·96	770	58	430	...	...	...	640
		1·40	750	61	...	500	...	...	...
		1·41	750	61	....	500	...	...	...
		1·61	750	46	...	370	...	...	...
Boron steels ...	Chatillon et Commentry ... *a* ? B.	·7 ?	800	26	250	...	...	...	...
	b ·5 % „	1·05	800	44	410	...	...	...	...
	c ·8 % „	·97	800	51	430	...	...	...	...
Chrome steels ...	Assailly ... ... C_1 2·5 % Cr.	·50	900	45	460	...	...	...	...
	C_2 2·8 % „	·82	900	56	500	...	...	...	...
	C_3 3 4 % „	1·07	850	57	530	...	...	...	...
Copper steel ...	Chatillon et Commentry ... 3 9 % Cu	·87	730	66	490	...	...	...	...
Tungsten steels ...	Assailly ... ... V_1 2 9 % W.	·55	850	51	460	...	...	...	800
	V_2 2·7 % „	·76	850	66	510	...	...	...	...
	V_3 2·7 % „	1·10	830	68	500	...	...	...	...
	Chatillon et Commentry ... *a* 3 2 % „	·77	800	65	550	...	...	...	...
	b 2 7 % „	1·02	800	69	540	...	...	...	...
	c 3·5 % „	1 53	1,000	50	320	...	...	...	...
	Boehler, Styria Special very hard ... 2 9 % „	1·10	850	74	530	...	...	...	...
	Boreas not hardened ... 7 7 % „	1·96	800	45	350	...	...	...	...
	„ hardened ... 7 7 % „	1 96	800	85	370	...	...	...	...
	Allevard ... ... 5·5 % „	·59	770	72	560	...	...	...	...
	5 5 % „	·59	770	74	...	680	...	...	850
Molybdenum steels	Chatillon et Commentry ... A 3 5 % Mo.	·51	850	60	530	...	...	...	...
	B 3 4 % „	1 25	800	82	480	...	...	...	...
	B 4 0 % „	1 24	800	85	530	...	...	...	...
	C 3 9 % „	1·72	770	73	510	...	...	...	...
			830	79	415	...	...	...	...
	C 3 9 % „	1·72	800	78	560	...	...	...	...
Nickel steels ...	Fourchambault ... ... N_1 3 6 % Ni.	57	730	55	...	...	490	...	...
	N_2 3 0 % „	70	730	48	...	...	535	...	640
	N_3 3 7 % „	1·21	730	48	...	...	480	...	...
Manganese steels ...	Fourchambault ... ... A ·7 % Mn.	·46	780	32	...	...	380	...	...
	B 1 8 % „	1·18	780	64	...	...	500	...	...
	C 2·2 % „	1 94	780	55	...	...	440	...	...
	AL ·3? % „	·9 ?	780	52	...	...	380	...	...
	BL 6? % „	9 ?	780	55	...	...	410	...	...
	CL 9? % „	·9 ?	780	54	...	...	390	...	...
	Hadfield Annealed ... 13· ?% „	1 0 ?	...	?	...	...	...	70	...
	Hardened ... 13· ?% „	1 0 ?	830	?	...	...	...	0	...
Silicon steels ...	Chatillon et Commentry ... I. ·11% Si.	·91	780	54	...	...	...	660	...
	II. ·64% „	91	780	50	...	...	...	660	...
	III. 1 28% „	·72	780	34	...	...	...	815	...

Length of all bars 20 cm.
T Temperature of hardening.
H_c Coercivity.
I_1 Residual magnetisation of bars of 1 cm square section.
I_2 Residual magnetisation of bars of ·85 cm. square section.
I_3 „ „ „ circular bars 1 cm. diameter.
I_4 „ „ „ „ „ ·5 cm. „
I „ „ „ closed magnetic circuits.

crack in hardening. The particular temperature of quenching between 740° and 825° has little effect on the magnetic properties, nor does a prolonged temperature of 780° have any injurious effect, but a low quenching temperature tends to save cracking. Experiments were made on quenching this steel in different liquids, warm and very cold water, mercury, oil, and water covered with a film of oil. The slower cooling produced by hardening in oil gave inferior results, but saved cracking, and from the considerable improvement in the coercivity as the result of mercury hardening, it would seem that very sudden quenching is beneficial, but more liable to produce cracks. It is suggested that water covered with a moderate layer of oil may be a useful compromise.

Boreas steel has very singular magnetic properties. It contains a large proportion, 7·7 per cent., of tungsten; a very large proportion, 2 per cent. of carbon, and 2 per cent. of manganese. Hardened in air it has the properties of ordinary tempered steel, and is used for tools in that condition. It is even then capable of strong magnetisation ($H_c = 45$. $I_1 = 350$), but when quenched in water the magnetic properties are strengthened, the coercivity greatly so ($H_c = 85$, $I_1 = 370$). This combination of great coercivity with moderate magnetic intensity, giving a moderate demagnetising field, renders it very suitable for short stumpy magnets. Boreas steel is not very homogeneous and works badly, and different bars give very different results.

Molybdenum Steels.—Of all the steels studied molybdenum steels gave the best results for magnets, but are not yet in commercial use. The presence of from 3·5 per cent. to 4 per cent. of molybdenum greatly improves the magnetic qualities of steels of all percentages of carbon, even as high as 1·7 per cent. With 1·25 per cent. of carbon and 4 per cent. of molybdenum, $H_c = 85$, $I_1 = 530$: with 1·72 per cent. of carbon, and 3·9 per cent. of molybdenum, $H_c = 78$, $I_1 = 560$. With magnetisation similar to that of the tungsten steels the coercivity is much greater. When the quenching temperature is raised, the resident intensity is diminished, but the coercivity remains the same or is improved. For example, one of the bars of molybdenum steel, with 1·72 per cent. of carbon, gave the following results:—

Bar quenched at 745°. $H_c = 73$. $I_1 = 465$.
" " " 830°. $H_c = 79$. $I_1 = 415$.
" " " 890°. $H_c = 76$. $I_1 = 300$.

The Influence of their Chemical Composition on the Magnetic Properties of Steels.—Among steels alloyed with carbon only the best are those having a percentage of about 1·2. The presence of a little boron, silicon, or manganese, seems to have no marked effect. Nickel, chromium, and copper improve the magnetic qualities. Tungsten and molybdenum steels furnish the best magnets. It is noticeable that the

Table II.—Closed Magnetic Circuits.

		Percentage carbon.	Coercivity.	Residual magnetisation.	Maximum intensity.	Hysteresis.
Carbon steels. Firminy ...		·06	3·2	625	1,560	28,000
		·20	7·4	770	1,590	68,000
		·49	19·3	835	1,525	108,000
	a	·84	52	605	1,230	170,000
	b	·84	58	670	1,155	217,000
		1·21	53	645	1,200	182,000
Carbon steel. Unieux		·96	50	640	1,175	165,000
Allevard steel, hardened. w = 5·5%	*a*	·59	73	850	1,240	280,000
	b	·59	70	850	1,230	265,000
" " not hardened ...		·59	26	900	1,515	115,000
Tungsten steel. Assailly. w = 2·7 %		·76	69	800	1,240	260,000
Nickel steel. Ni = 3 % ...		·70	54	640	990	177,000
Manganese steel. Mn = ·7 % ...		·46	33	860	1,390	142,000

metals, nickel and chromium, whose influence is relatively small, principally affect the low carbon steels, while the more active elements improve steels of all percentages of carbon. The presence of molybdenum or of tungsten in large quantities greatly affects the magnetic qualities even of very high carbon steels. The residual magnetisation of a molybdenum steel, *e.g.*, B, Table I., is about the same as a tungsten steel, such as the Allevard steel, but as the coercivity of the former is much greater it is probable that the residual magnetisation of a ring of Allevard steel would be much greater than that of the molybdenum steel. The Allevard steel then is to be preferred for closed, or very nearly closed, magnets having small demagnetising fields, but for open magnets molybdenum steel is better on account of its greater coercivity.

Magnets in the form of Closed Rings.—The previous results all refer to bar magnets. The experiments on rings are so much more laborious that many fewer were made and on fewer kinds of steel. Moreover, notwithstanding that the ring method corresponds more closely to theoretical conditions, the author gives more weight to the experiments on bars, since the character of the steel is liable to modification by the process of forging, and the number of experiments made were by many fewer. Generally speaking, the results of the experiments on rings agree with those on bars. Some results are tabulated in Table I. Table II. gives some additional figures.

(*To be continued.*)

THE TRANSFORMATION FROM TRIPHASE TO MONOPHASE ALTERNATING CURRENTS.

L'Eclairage Electrique for December 31st, 1898, contains an account of a method devised by M. Grassi, by which, in an unbalanced triphase circuit, the same quantity of energy can be taken from each of the primary circuits, whatever be the difference of load on the three secondary circuits, so that it is applicable to the particular case in which two of the secondary circuits have no load. This particular case, then, gives a transformation from a triphase system to a monophase one.

The apparatus (fig. 1) has the form of an ordinary triphase transformer, whose three secondary coils, each containing the same number of turns, are connected in series.

In the figure, the primary winding on the core, B, is in

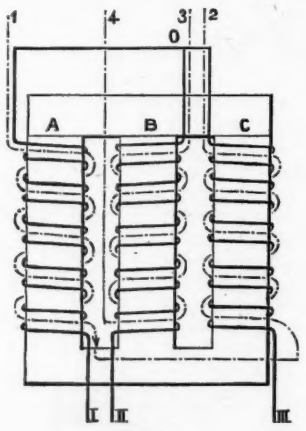


Fig. 1.

the opposite sense to those on cores A and C. The secondary windings on cores A and C are connected in opposite senses. Whatever be the sense of the secondary winding on the core, B, the total pressure is the same, and equal to twice that between the terminals of any one of the secondary coils.

The apparatus used by M. Grassi contained 310 turns for each primary coil, and 77 for each secondary coil.

The author finds that by winding the primary coil, B, in the opposite sense to those on A and C, a more equal division of the energy absorbed by the secondary is effected in the primary circuits. The chief objection to this primary winding is that the no-load current is greater, and the losses somewhat increased. This defect is remedied if the number of turns on the primary coil, B, is modified. If, in particular, double the number of primary turns is put on one of the cores, the loss is as low as in ordinary transformers.

The author has studied the influence of the number of

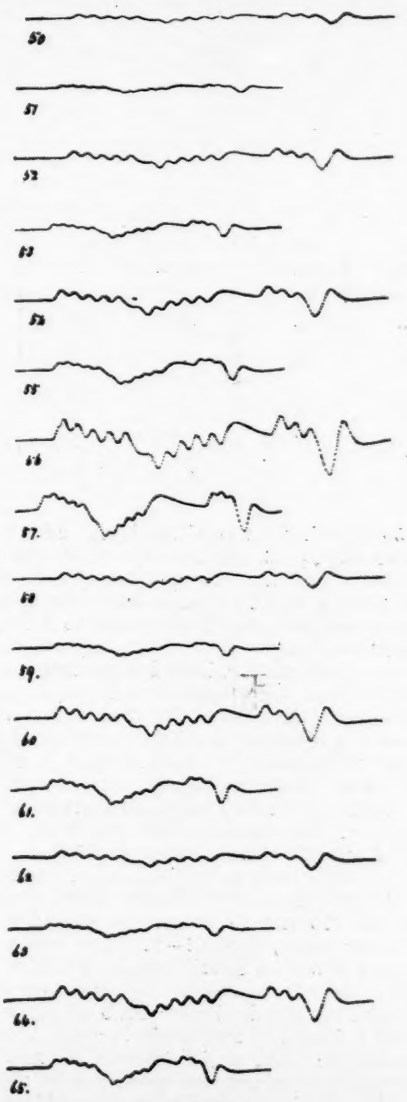
secondary turns on different cores. He finds that better working conditions are obtained when one of the coils A and C have a number of turns a little less or a little greater than those of the other two, and when the coil B is wound in the same sense as the secondary coil A or C having the greater number of turns.

SIPHON RECORDER SIGNALS.

By J. RYMER-JONES.

(*Continued from page* 38.)

ALTHOUGH a great improvement on working without condensers at either end of the longer cable, C, signals are still somewhat wavy, and, unless large, show little definition between a series of similar signals. Rather wavy signals are, however, sometimes preferred by those accustomed to them, to signals having much greater definition between their component elements, which condensers at both ends tend to produce.

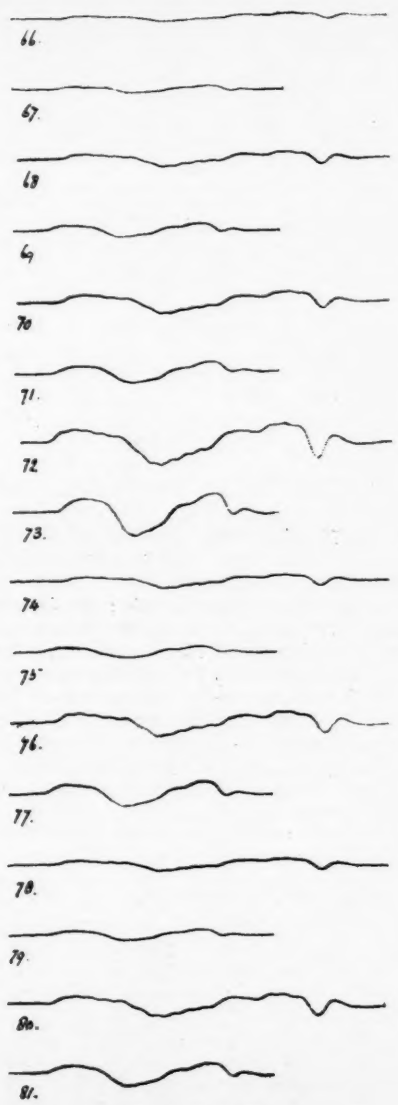


SLIPS 50 TO 65.

Although maximum definition is obtained with condensers at both ends, considerable confusion may arise when the cable has only a moderate K R on account of consecutive similar signals falling towards the zero line, and from their keeping too near to, or even throwing across, the zero line, owing to the excessive curbing effect of the condensers. In this case it is not very clear where one letter ends and the next begins. For rather short cables, therefore, a condenser at one end only is more suitable than condensers at both ends, because signals are not so sharp and sometimes even jagged, and also are further removed from the zero line and keep more parallel with it. The *fall* towards the zero line can be modified by adjusting the bifilar suspension, and also by shunting S C or R C with a high resistance, as will be illustrated later on, and is only here referred to as showing the increased curbing effect when S C and R C are both employed.

In the case of the shorter cable *c*, it does not make any noticeable difference in the shape or size of signals whether S C or R C be the larger of the two condensers, and this applies to both 16 and 25 w.p.m. (*see* series *y*, *z*, *α*, *β*), and also to the longer cable C.

With condensers at both ends of the longer cable C, increasing the capacity of either the sending or receiving condenser from 30 to 60 microfarads, increases the size of the waves, but the definition is not very much better than with S C and R C both 30 microfarads (series *η*, *θ*, *i*, *κ*). In fact, rather less wavy and as well defined signals are obtained when S C = 60 and R C = 30 microfarads (slips 76 or 80) as when R C is increased to 60 microfarads (slip 72). Increasing S C from 30 to 60 microfarads (78)—R C remaining unchanged at 30 microfarads—gives much smaller signals than with S C = 30 microfarads, and double the sending battery (68) both in the case of cable C and *c*, but increasing both S C and



SLIPS 66 TO 81.

Signalling Condensers at Both Ends.

		16 w.p.m.						25 w.p.m.				
Cable.	Series.	Slip.	Cells.	Recr. s.	S C.	R C.	Series.	Slip.	Cells.	Recr. s.	S C.	R C.
c	*u*	50	15	150$^{\omega}$	30	30	*v*	51	15	150$^{\omega}$	30	30
		52	30	"	"	"		53	30		"	"
"	*w*	54	15	"	60	60	*x*	55	15	"	60	60
		56	30	"	"	"		57	30	"	"	"
"	*y*	58	15	"	30	60	*z*	59	15	"	30	60
		60	30	"	"	"		61	30	"	"	"
"	*a*	62	15	"	60	30	*β*	63	15	"	60	30
		64	30	"	"	"		65	30	"	"	"
C	*γ*	66	15	1,000$^{\omega}$	30	30	*δ*	67	15	1,000$^{\omega}$	30	30
		68	30	"	"	"		69	30	"	"	"
"	*ε*	70	15	"	60	60	*ζ*	71	15	"	60	60
		72	30	"	"	"		73	30	"	"	"
"	*η*	74	15	"	30	60	*θ*	75	15	"	30	60
		76	30	"	"	"		77	30	"	"	"
"	*ι*	78	15	"	60	30	*κ*	79	15	"	60	30
		80	30	"	"	"		81	30	"	"	"

						Battery increased to obtain the same size of signals as with the larger condensers.				
Cable.	Slip.	Cells.	Recr. s.	S C.	R C.	Slip.	Cells.	Recr. s.	S C.	R C.
c	94	15	300	30	30	...	...	300	30	30
"	95	"	"	60	60	96	36	"	"	"
C	97	"	∞	50	50	...	...	∞	50	50
"	98	"	...	100	100	99	29	"	"	"
						100	27	"	"	"

See also slips 88 and 92.

R C to 60 (slip 70) gives rather larger signals than slip 68. With 50 microfarads at both ends (slip 83), signals, though smaller with the same battery, are less wavy and better than with 100 microfarads at each end (85); also 50 microfarads and 30 cells give much better signals, though not quite so large as 100 microfarads and 15 cells (88, 89), thus showing one way in which signals may be improved, viz., by apportioning S C and R C to suit the particular cable. The object, however, has not been to get the *best* signals, but merely to compare the characteristics of signals through a long, and also a moderately long, cable at two different speeds and with different values of signalling condensers at their ends.

16 w.p.m.					
Cable.	Slips.	Cells.	Recr. s.	S C.	R C.
	82	15	500$^{\omega}$	50	50
	83	30	"	"	"
C	84	15	"	100	100
	85	30	"	"	"
"	86	"	3,500	50	50
	87	"	5,000	"	"
"	88	30	4,000	50	50
	89	15	"	100	100
"	90	30	1,300	100	100
	91	"	1 500	"	"
"	92	15	4,000	100	100
	93	13	"	"	"

Slips 85 and 86-87, and also 88 and 89 show that with 30 cells in each case it is better to use 50 mfds. and a larger shunt on the recorder than 100 mfds. and a smaller shunt resistance.

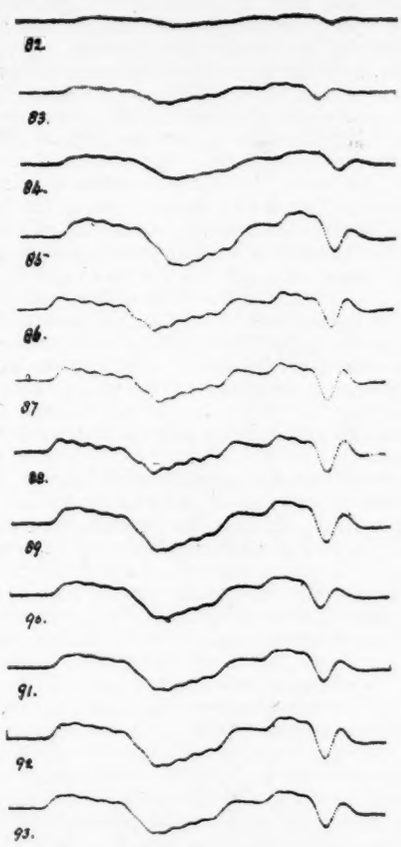
Slips 98 and 99-100, show that in order to improve definition it is better to increase the battery [if the D R of the cable permits] than the condenser capacity beyond 50 mfds. in the case of the longer cable C; but for the shorter cable, *c*, 36 cells are required to give the same signals when S C and R C both equal 30 mfds. as when they are both 60 mfds. with 15 cells, so that the condensers may be increased with advantage in preference to battery power. See slips 96 and 95.

With the shorter cable, *c*, instead of the first two elements of 5 and 0 having the appearance of a *rise* from the zero line while succeeding elements fall towards it—as observed in the case of a condenser at one end only—the tendency is for the first two signals at 15 w.p.m. to show a decided *fall* (slip 52) while succeeding signals also fall but to a less degree. At 25 w.p.m. the first two elements are at about the same level, or even show a slight *rise*, while there is a marked fall after the second element (slip 53).

With the longer cable, C, the *fall* is much less marked but is still noticeable, when several similar signals succeed each other, at both 15 and 25 w.p.m. and especially with the higher battery power, slips 66—81. The reason why the fall during 0 is so much greater than in the case of 5, is that the latter precedes it and charges the cable so as to produce a much larger initial deflection for the 0 which immediately follows and is formed by the opposite current.

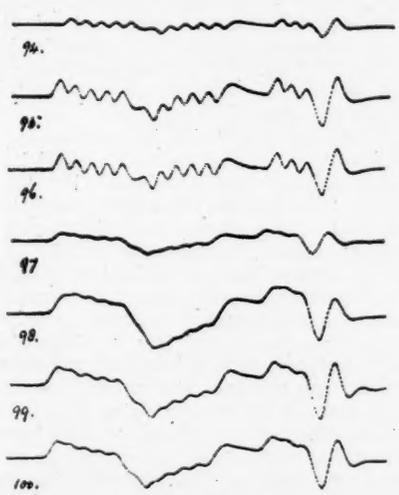
If signals *rise* from, or *fall* towards, the zero line, and their size admits of it, they can sometimes be made a little more parallel with it by reducing the shunt resistance on the recorder coil, or the battery power, owing to the siphon moving more sluggishly under the weakened current. The current strength does not alter the *shape*, except in the case of very small signals which become modified by the inertia of the coil, and in so far as larger waves make the siphon move more freely and to a greater distance from the zero line in a given time; and if the character be wavy, the waviness becomes more apparent. If signals are very small, doubling the battery more than doubles the size of signals, inasmuch as the inertia of the coil and friction of the siphon have less effect on increased electrical impulses.

Altering the *speed* of working modifies not only the size but sometimes also the *shape* of signals, especially if small, and a condenser be used only at one end; hence one advantage of *automatic* versus *hand* transmission, in order to



SLIPS 82 TO 93.

secure regularity and uniformity for high speeds. Thus slips 11 and 12, 19 and 20, 23 and 24, show that at 25 w.p.m. consecutive similar signals *rise* before falling, whereas at 16 w.p.m. the preliminary rise is scarcely noticeable.



SLIPS 94 TO 100.

Another important advantage of auto-transmission is that it secures mathematical accuracy and enables signals like *e*, *i*, *s*, *h*, and fig. 5 (or, *t*, *m*, *o*, and fig. 0) to be easily distinguished by their relative lengths when there is little or no definition between their component elements; and as automatic sending also obviates peculiarities in hand transmission and bad spacing (especially at a high speed) an increase in the rate of signalling becomes possible.

(*To be continued.*)

NOTES ON THREE-PHASE AND TRAMWAY WORK.

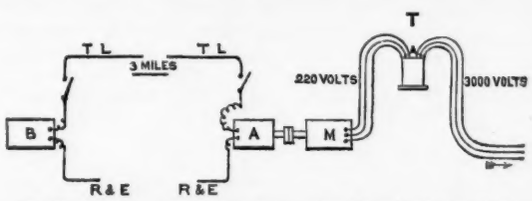
BY ARTHUR GIBSON, A.I.E.E.

A CERTAIN three-phase electrical installation transmitting power to operate motors of various sizes was short of water at the turbines of its two generating stations, and to relieve the plant of the tramway load another generator was installed and connected to the tramline, the power to drive it being furnished by an existing Pelton wheel.

The amount of power available at this wheel did not reach the capacity of the machine, and it had no governor. The sketch shows conditions and connections at a glance.

Before the addition of B generator, the tram generator A was used, being direct coupled to the polyphase motor shown in the sketch, the main three-phase plant going day and night.

Upon starting the additional generator the following effects were observed:—The tramway could be run in the usual way with, however, certain controlling devices. But upon running generator A in parallel with generator B, the latter not only



T L, Trolley line; B, 600-volt tram generator driven by Pelton wheel; R & E, Rails and earth; A, 550-volt tram generator; M, Three-phase motor started up with rheostat in rotor circuit; T, Transformer; —, To the three-phase installation.

handled the tram load, but by applying all the available power it was found that whenever the tramway demand was less than the capacity of B generator and its Pelton wheel, the surplus current operated generator A as a motor and the polyphase motor appeared to generate current which assisted the whole of the three-phase system. It was difficult to tell precisely what was going on, the polyphase motor had a heavy lag current and whether it was driving or driven, little or much, the amperemeter readings varied only 20 per cent., but upon opening the switch between it and the transformer the whole of the tram section raced.

Inserting resistance in the rotor circuit had the same effect. That the high tension generators were assisted in their work was evident from the reduced kilowatt readings. An experiment was also made with a hauling engine driven by a three-phase motor, the result was practically the same, *i.e.*, the load was lowered with the motor full on and all brakes off, the speed being somewhat above that of the same motor when hauling in the usual way, and the amperemeter readings had the same characteristics, the cosine of angle of lag in the case of this motor being rather less than in the former one. The reason for the above behaviour is not quite clear to the writer, though in the eternal fitness of things the action seems natural.

If no one can step in to explain this circumstance, it may be filed along with Mr. W. M. Mordey's remarks anent short-circuiting alternators when testing, and left for our professors to explain.

The Royal Society.—Among the papers set down for reading yesterday afternoon was one by Prof. K. Pearson, F.R.S., and Miss Lee, "On the Vibrations in the Field round a Theoretical Hertzian Oscillator."

THE INSTITUTION OF ELECTRICAL ENGINEERS.

At the meeting of the Institution of Electrical Engineers on the 12th inst., the discussion was continued on the papers "Improvements in Magnetic Space Telegraphy," by Dr. Oliver Lodge; "Telegraphy by Magnetic Induction," by Mr. Sydney Evershed; and "Ætheric Telegraphy," by Mr. W. H. Preece.

The first business was the presentation of premiums to Messrs. Parshall, Hammond, Leonard Andrews, and H. N. Allen, and to students of the Institution for papers submitted during the past session.

Mr. Evershed took the opportunity of correcting a slip respecting the size of condenser necessary for use with the system described in his paper. He chose to work at 12 periods per second, and thereby reduced the size of condenser. Its capacity was only "appalling" at high frequencies.

Dr. Lodge resumed the remarks he had not quite finished the previous evening, and since that time had found much more to say, but supposed the members were waiting anxiously to get on to wiring rules, whereat there was a laugh, and general disclaimer of desire to do anything of the sort which would cut short the interesting remarks of Dr. Lodge, who expressed his sorrow at taking up so much time, but emphasised his opinion that the subject was one well worthy of attention by the Institution. One of the advantages of the Society was that such matters are well threshed out.

Dr. Lodge thought that another slip might have been pointed out in connection with statements as to the power required by relays at different frequencies, and particularly with reference to the one at Lavernock; the power actually varied as the square of the frequency. The circuit at Lavernock was, he believed, of low resistance, therefore in the equation

$$C = \frac{p\,R}{p\,L}$$

the $p\,L$ term was, say, 10 times as great as the resistance term. When the frequency is high, or, say, down to 100, the p's are cancelled. The statement that the power is so much greater at a high frequency than a low one might be corrected. Probably it would be said that the circumstances at Lavernock are peculiar, and the relay not set in so sensitive a condition as when shown at the Institution. Then earth currents have to be considered, and so on. Dr. Lodge had not yet had the opportunity of fully testing his apparatus under similar conditions; when he did get that opportunity he might find it less sensitive than he should like.

As to the power used in his magnifying telephones, he had made some experiments. A primary circuit was formed of a coil in series with a dynamometer and alternator. Fifty feet away another coil was placed in series with the first telephone whose relay contact operated a second telephone and local battery, and this, again, a third loud-speaking telephone. With the following constants:—

Frequency, 384 per sec.	$M = 47$ cms.
Prim. current, 0·1 ampere	$p\,L = 11$ or 12.
Res. coil and first telephone coil, 0·9 ohm.	

When an audible note was just given the secondary current was comparable to a micro-ampere at a pressure of a micro-volt, and the power was a micro-micro-watt. The actual fraction of that which goes to move the coil is infinitesimal, the figure given being the gross power. He did not think much of these measurements of power, although any sensitive instrument, such as a galvanometer, might have its power expressed in micro-watts. He thought his telephone was 30 times as sensitive as an ordinary telephone, but hardly to be called a motor, while the coil in Mr. Evershed's relay actually moved. In his apparatus there was nothing like a perceptible movement, and all the telephone had to do was to vary the pressure on the carbon contacts. The action resembled throwing a trigger to throw fresh energy (from a battery) into the circuit.

On the next subject—Opacity Calculations—Dr. Lodge realised the reconciliation between the Maxwellian and Mr. Whitehead's equations—both were right but represent extremes—if either were wrong it seemed to be Maxwell. Mr. Heaviside had given the more general theory, and when one worked it out, it reconciled the whole thing. Dr. Lodge asked if the cable at the Goodwin Sands was sheathed in iron, if the ship was of iron, and the cable in the ship? Some experiments made on the effect of neighbouring conductors by copper sheet, tinfoil, and pan of acid, appeared to show that they were not of much account.

Prof. J. J. Thomson's examination of the effect of the earth on the position of two coils was interesting. Suppose they were horizontal; if the whole body of the earth conducted anything like as well as sea water, one might almost as well have the earth a perfect conductor, and the telegraph then would not work. A coil above would be imaged by a coil beneath. This was very deadly, if borne out by examination and criticism, to horizontal coils. Mr. W. H. Preece would be glad to hear that Dr. Lodge was coming round to the notion of vertical coils, and this examination of Prof. J. J. Thomson was of importance. With vertical coils the conductivity of the earth, so far from hindering, actually helps the vertical coils. The image coil below the surface tended to increase the effect; the lines of force passed in opposite directions through the image and assisted, as they were in phase, doubling the effect. He did not suppose the effect would be actually increased so much as that, but it would be assisted.

Vertical coils would be especially good for ship signalling, as they could be formed of a conductor run from stem along over tops of masts and down to the stern, being earthed at stem and stern. The received effect would be partly due to earth tapping as well as induction. The effect would depend upon the aspect of the ship to the sending station; it could signal side on but not end on. The great thing would be to get the apparatus in use as a fog signal and for speaking to lighthouses. Here Dr. Lodge gave some humorous particulars of what might occur, and pointed out that the one defect would be that when two vessels were end on, tending to collide, they could not speak, and if the apparatus was in bad order the signal would seem to come from a distance.

He then elaborated Sir Henry Mance's proposal for "tone" signals, and showed how a ship entering a harbour might be given its bearings from two signal stations, each having a characteristic signal note. He concluded by thanking Mr. Preece for the powerful aid of the G.P.O. promised in connection with future trials.

Mr. W. P. Granville, in attempting to discuss the papers before the meeting, proposed to emphasise the practical side of the problem. Because of the practical difficulties, wireless telegraphy would be limited to cases where ordinary telegraphs were not practicable. He then referred at some length to the experiments of the late Mr. Willoughby Smith, whose address of 1883 has been overlooked by many of the younger workers, and described some out of the large number of experiments made on magnetic induction. Although Mr. Willoughby Smith suggested telegraphing to trains in motion, the idea was not taken up kindly. Times have changed since then.

Mr. Granville and Mr. Smith, jun., had during the last 10 years been engaged in devising some method for communicating with outlying rock lighthouses. For the Needles Lighthouse in Alum Bay they had devised a system which seemed suited to the purpose. Now, lighthouses afforded excellent object-lessons of the difficulties met with on ordinary days, and the inconveniences to be faced by operators whose sole mode of approach, in many cases, is to be swung in by a long fishing-pole arrangement. The tower at the Fastnet is of boiler plate, and parts not of iron are of bronze, the rock alone being non-absorptive. A long base was unobtainable. What was done was to reduce wireless telegraphy to the least common multiple, as it were, by laying a line out towards the rocks and ending it in the sea. A short base line was laid down on the rock ending in earth plates, and signals were sent by the earth tapping, the receiving instrument being a sensitive galvanometer. Mr. Granville also pointed out that earth leakage might assist even where the receiving coil was not earthed.

Major Brett regretted that Dr. Lodge had forsaken the Hertzian wave. As the survival of the fittest, he thought the Hertzian wave was going to survive. With this method experiment is enormously easier than calculation, and one did not need a private estate

whereon to erect huge lines. As a practical example of the method, comparable, he thought, with that at Lavernock, there was the Marconi transmission between Alum Bay and Bournemouth, 17 miles apart, and the special case of the East Goodwin lightship and the South Foreland lighthouse. There was a fatal want of mobility in electro-magnetic systems, whereas the coherer possessed a very fair amount of mobility indeed.

Mr. Dane Sinclair proceeded to impress upon the meeting the difficulty of making a good earth. Earth plates many miles apart usually, however, can be made to give good earth. He also pointed out that Dr. Lodge's telephones might be made to act as relays in telephonic work and would be of large practical importance.

Mr. Brown discussed a method he thought might be employed whereby the advantages of low frequency in transmission and high frequency on the receiving instrument might be obtained.

Prof. Lodge then replied. He said experiment was never absurd. He had not forsaken the Hertzian system, but his paper was on a different aspect. He pointed out that the resistance of earth was independent of the distance between the earth plates if they were so far apart that their size did not come in.

Mr. Evershed briefly referred to the relation between power and frequency. He was glad that Dr. Lodge had given the power used in his telephone, but the C^2 R losses had been given, omitting the back E.M.F. If the mechanical work done was negligible compared with the C^2 R losses, the efficiency of the apparatus should be increased by raising the back E.M.F.

The cable was put outside the lightship in his experiments, but the cable was armoured; the absorption was only 10 per cent. at 16 periods. He had experimented on absorption, and found Mr. Whitehouse's calculation agree within a small difference. Maxwell would give an entirely wrong result. He replied to several statements regarding cables by pointing out the excessive tidal scour in the Channel. One or two remarks on Hertzian work concluded the reply, and the meeting adjourned until 26th inst., when a discussion on "Wiring Rules and Regulations" will be commenced by Mr. Wordingham—the papers submitted being taken as read.

CORRESPONDENCE.

The Shoreditch Dust Destructor.

After two months' work on the "Avarice of Municipalities," I am sure none of your readers will grudge me a little recreation amongst the rhetorical flowers which flourish so luxuriantly on the banks of the Shoreditch. I am not acquainted with that Garden of Eden, beyond the fact that its address is E.C., but I know, to my sorrow, that it possesses a dust destructor, concerning which, some 12 months ago, I wrote you a short letter. It must have been a very impressive letter, for I am inundated with inquiries for my private opinion on Shoreditch and its works from all parts of the kingdom. These private opinions are, of course, all of the "gratis" description—as they should be amongst engineers—so if you will kindly grant me a small piece of your valuable space, I will present the results of all my investigations to all readers of the ELECTRICAL REVIEW, even at the risk of being told that an opinion is worth just what it costs—in this case, 4d.

I am in the happy position of knowing none of the disputants, except Mr. Hammond, who dropped in accidentally. They may be just the people one would like to know, but, for the moment, it is better that we never speak as we pass by.

Borough surveyors and electrical engineers want to know the net result; therefore I shall not attempt to determine the origin of all the undercurrents which have influenced the drift of this most protracted correspondence, I shall confine myself absolutely to results obtained at Shoreditch compared with those of electric lighting stations burning coal only.

In your issue of November 18th, 1898, Mr. T. W. Baker gave a summary of the accounts, and as this has not been objected to I propose to accept it as correct.

From Mr. Baker's summary I take all the figures as follows:—

ELECTRICITY ACCOUNT.

Dr.	£	s.	d.
To Coal	432	15	9
„ Stores, water, and insurance	896	4	0
„ Wages	1,472	13	10
„ Engineer's salary and expenses	469	10	9
„ Parochial rates	158	12	3

DESTRUCTOR ACCOUNT.

To Wages...	2,746	1	7
„ Engineer's salary	83	6	8
„ Stores, &c.	411	16	4
„ Removing clinkers	612	10	5
„ Insurance	43	4	2
	£7,326	15	9

Cr.	£	s.	d.
By Sales of current	8,254	2	1
„ Miscellaneous income	120	4	7
„ Sale of stores to other departments ...	130	8	4
„ Destroying trade refuse	233	1	9
„ *25,404 tons of refuse destroyed at 3s. ...	3,810	14	3
	£12 553	11	0

* This is the previous cost of barging the refuse down the river.

The financial result of the working is, therefore, expressed thus—

	£	s.	d.	£	s.	d.
To total receipts				12,553	11	0
By total cost	7,326	15	9			
By balance	5,226	15	3			
	£12,553	11	0			
Gross profit				£5,226	15	3

I cannot quite make out the exact distribution of capital employed, but it appears to be thus—

	£	s.	d.
Capital expended on electric lighting ...	83,935	0	0
„ „ dust destructor ...	22,104	0	0
	£106,039	0	0

This capital has cost for interest and sinking fund, according to Mr. Baker—

	£	s.	d.
For electric lighting	3,457	2	5
For the destructor	1,515	3	8
	£4,972	6	1

So that, after deducting this sum from the gross profit of £5,226 15s. 3d., there remains a net gain to the ratepayers of £254 9s. 2d.

If these works had belonged to a company, the directors might, and probably would, have declared a dividend of 4 per cent., and carried forward nearly £1,000, but as they belong to a local authority certain charges have to be met before a "profit," according to their particular view of "profit," that is, something beyond interest and sinking fund, is actually realised.

In connection with this matter, the first thing that strikes me is that whereas the lighting capital is four times the destructor capital, the charges for capital on the destructor are nearly one-half of those on the lighting plant—that is to say, nearly double *pro rata*.

This is due to the loans having been granted for 42 and 15 years respectively.

I am not prepared to express any opinion as to the wisdom of the London County Council in making this distinction between the two undertakings, but it is obvious that destructors are, or ought to be, specially remunerative to permit of the capital being paid off in 15 years, when municipalities are required to pay off gas loans in 60 to 100 years.

Probably this extravagantly rapid rate of repayment of the destructor capital has been responsible for misleading some of your correspondents as to the results obtained at Shoreditch. I am free to confess that I had not realised its importance until I carefully compared the capital charges with the capital employed.

I think that no one, at least, no municipal engineer, will dispute the statement that in this respect Shoreditch is handicapped to the extent of £700 a year, a small sum in itself, but a serious item in the debits of a first year's work-

ing, particularly when all the world is standing round eager to count the golden sovereigns as they fall into the ratepayers' money-box. (I think I am right in assuming that all the Shoreditch critics would be deeply grieved if there were no sovereigns to count, and one of my objects is to make them as happy as the circumstances will permit.)

I imagine that my municipal friends, after reading my various remarks on the way they manage gas, would not think me fair towards Shoreditch, unless I took account of the price per unit charged to the consumer.

I have tried to get at the exact figure, but have had some difficulty. I give you the result of my examination for what it is worth. I believe it to be fairly correct.

The prices charged have been on the Wright system, 6d. for the first two hours and 4d. after.

The price for power, 2d. down to 1½d.

The price for public lighting, including cleaning and trimming, 5d. per unit.

The net average price received equals 3·73d. per unit sold, or from private consumers only 3·45 per unit.

It will be observed at a glance that these prices are very low. The average price realised by the four local authorities owning electricity works in London is 5·39d., so Shoreditch has beaten the average, by 1·94d.

But the London average includes St. Pancras, which is now seven years of age and has an output of 1,520,354 units, therefore to make the comparison fair to Shoreditch, we should take the Islington results, which, in its second year of working, are, I think, fairly comparable with those of Shoreditch. The leading figures are as follows :—

	Islington.	Shoreditch.
Capital expended	£144,226	£106,039
Year of working	2nd.	1st.
Units sold	503,572	514,200
Units sold to private consumers...	...	410,486
Price realised	6·01	3·45
Annual cost of loans	£4,750	£4,972 6s. 1d.
Result	£318 *loss*	£254 *profit.*

The value of the difference in the sale prices of the units sold is for Shoreditch, 410,486 at 2·56d. = £4,378 10s. This sum should, for purposes of comparison, be added to the £254 profit, making a total of £4,632 10s.

It appears to me that if the Shoreditch works had been planted in Islington and had charged Islington prices, this sum of £4,632 10s. would have appeared as surplus profit, and Merry Islington would have been as gay as in days before electric light was dreamt of.

In presenting these few figures for the consideration of your readers, particularly of those who take an interest in destructors combined with electricity works, permit me to explain that I have made no corrections or allowances of any kind, either on one side or the other, and I leave it entirely to men of municipal experience to judge whether the above apparent gain of £4,632 ought to be increased by, say, £700, as an allowance for the exceptionally heavy charges for capital, to which Shoreditch appears to be subjected.

John S. Raworth.

Sparking at Commutators.

The following simple method of finding which segments of the commutator of a dynamo are causing sparking, may be of interest to some of your readers. I am not aware that it has been published before. Mark a few of the bad looking segments 1, 2, 3, &c. Now run the dynamo, and it will be seen that the marks near the sparking segments appear to stand still, being instantaneously lit up as these segments pass under the brush. The marks should be placed on circles of revolution having different diameters. Unless this is done the marks will apparently run into each other and cannot then be distinguished. If the marks can be made on the verticle lugs of the segments, these marks will appear to stand still and in a line above one another at the brush. The commutator should be shaded and only illuminated by the sparks. Having found the segments, a touch of the file will often correct matters. This may save taking the armature out for skimming up, and, at any rate, will stop indiscriminate filing.

R. Percy Lovell.

The Quay, Dartmouth.
January 9th, 1899.

Cowper-Coles Cyclic Process.

I notice in your issue of January 13th the letter signed "F."

If "F." is really desirous of making himself acquainted with the "novelty and utility" of my cyclic process for the treatment of complex sulphide ores, I shall be very pleased to give him any information he may require. No man is obliged to condescend to answer the attack of an anonymous assailant, but I have felt impelled to take some notice of the letter of "F." and certain other anonymous writers, as I have a strong suspicion that I know one or more of the faces that lurk behind the mask of anonymity. I wonder if my suspicion is a true one? Have "F.," "Pertinax," or "Cyclist" the courage to publish their names?

Sherard Cowper-Coles.

An Easy Method of Writing Articles.

Mr. Cowper-Coles seems very proud of his borrowed plumes, but his reply renders his case still worse.

He is evidently one of those of whom the old philosopher Cardan said—*transcribunt non scribunt.*

Can we expect that, after this lesson, the articles which will bear his name will have been written by him?

If he finds my remonstrance ludicrous, how shall I describe his coolness?

Pertinax.

Combined Lighting and Traction Stations.

I read with interest your "Leader" of 6th inst. on this subject, but I am afraid I am not convinced that the Plymouth system, if correctly described, is an advance in economy or otherwise upon the plan adopted at Dover and Halifax.

The use of combined "engine-alternator-dynamo" sets as described would only be justified under the following conditions :—(1) That the lighting and traction would each require the same amount of power, and that subsequently they would each grow at the same rate; (2) that the maximum traction and lighting loads would never occur simultaneously.

I think we all agree that such conditions are unlikely to exist in any district.

As to the question of spare plant, it is evident that, even if spare engine power were entirely dispensed with, the reserve dynamo power would equal twice the full load capacity of the station. Economy in plant is one of the claims made for the system.

David Stevenson.

LEGAL.

Stegmann v. O'Connor.

In the Queen's Bench Division on Saturday, before Mr. Justice Bruce and Mr. Justice Channell, sitting as a Divisional Court, an appeal from a decision of the Official Referee in the action at the instance of Mr. George Stegmann, electrical engineer, against Mr. O'Connor, of Mount Cashel, Clapham, came on for hearing.

Mr. Tindal Atkinson, for the plaintiff, said he had to ask their Lordships to set the decision aside because it was against the weight of the evidence, and because the Referee's decision was against the contract and specification. The plaintiff was an electrical engineer, and in April, 1898, the defendant, who was having alterations made on his house, Mount Cashel, Nightingale Lane, Clapham, required an electric installation, and his architect prepared the specifications. The contract was given to the plaintiff and he proceeded to execute it; but a complaint arose that he was not finishing the work in time, and the work was completed by another engineer. The Official Referee found that the work was not done according to the specification. He allowed to the plaintiff a certain amount for the actual value of the work taken over by the engineer who was substituted for the plaintiff, and he gave a penalty of £50 for the non-completion of the work, and he ordered judgment to be entered for the defendant on the claim and counterclaim for £38 1s. It was in respect of that that the plaintiff complained. He said he did not complete the work. It was true he admitted that in one particular he did not do it according to the specification; but he completed it so that the installation would work all right, and that in the circumstances the Official Referee was wrong in penalising him. The point was the true construction of the specification. It provided that all the wires were to be encased, and what the plaintiff had to do upon the construction of the specification was to encase the wires in American

wood, and then paint the wood so as to prevent decay or corroding. But it was said that he should not have used wooden cases at all but "compo" cases, and sink them into the walls, because it was said that that was a better preservative for the wire. The amount of the contract was £76 10s.

Their LORDSHIPS pointed out that the casing was to be "proper," and the Referee evidently did not think American wood cases "proper."

Mr. ATKINSON submitted that when "compo" cases were required, they were always specified.

At this stage the further hearing was adjourned until opposed motions on the civil side are again taken, which will be in about a fortnight.

BUSINESS NOTICES, &c.

Annual Dinner.—The Langdon-Davies Electric Motor Co.'s annual dinner was held on Saturday, 14th inst., at the Bridge House Hotel, London Bridge. Mr. A. Soames (managing director), occupied the chair, supported by Mr. W. Langdon-Davies (engineer), and Mr. W. S. Davidson (works manager.) About 50 sat down to a most enjoyable repast.

Bankruptcy Proceedings.—At the London Bankruptcy Court last Wednesday, an application was made to Mr. Registrar Brougham for a recision of the receiving order that has been made against the estate of J. E. Liardet, 16, Hyde Park Gate, W., electrical inventor and patentee. An order was made for the application to stand adjourned *sine die*.

Liquidation Notices.—The Direct Telephone Exchange Syndicate has resolved to wind up voluntarily, and Mr. J. Featherstone Smith, of 8, Minories, E.C., will act as liquidator.

Creditors of the Improved Incandescent Electric Lamp (Foreign Patents) Syndicate should send their names, &c., and the usual particulars, to Mr. R. Ballard, 20, Jewry Street, E.C., the liquidator, by February 21st.

The Begtrup Governor.—Messrs. Browett, Lindley and Co., Limited, of Patricroft, are circulating a list of the "Begtrup" inertia shaft governor, which was described and illustrated in Mr. Davidson's paper on "Steam Engine Governors," recently reprinted in this Journal (see ELECTRICAL REVIEW, January 6th, 1899, page 31). The governor is extensively used in the United States, and Messrs. Browett, Lindley have secured the sole right to manufacture and sell in Great Britain.

Calendars, Lists, &c.—Messrs. Nalder Bros. & Thompson send one of their usual handy-sized wall calendars for 1899.

The Edison & Swan United Electric Light Company send us an illustrated list of "Ediswan" ball fittings.

Messrs. Fleming, Birkby & Goodall, Limited, of West Grove Mill, Halifax, send us an 1899 calendar with a separate sheet for each month.

Messrs. Beanland, Perkin & Co., of Leeds, send us a list of their improved horizontal steam engines for electric lighting, and also a list and specimen of soldering flux.

Change of Address.—Mr. G. Guy, electrical engineer, &c., has removed from 2, Orchard Street, to 14, Orchard Street, W.

Copper.—Copper statistics furnished by Messrs. Henry R. Merton & Co. show that the total stocks on January 15th, 1899, were 26,578 tons, against 27,896 tons on December 31st last, 26,904 tons on December 15th, 1898, and 31,955 tons on December 31st, 1897. The totals include the quantities advised by mail and cable, being respectively 4,950 tons, 5,550 tons, 5,300 tons, and 4,500 tons.

The "Educational Review."—We have received the first number of a new series of the *Educational Review*, a monthly magazine claiming to be devoted to the science and art of education, and a review of current educational literature and events. For a paper recognising that it is a "pedagogic monthly," we find the *Educational Review* very interesting in its able treatment of a few of the many questions of the hour affecting the interests of education. It is published at 203, Strand, W.C.

Electric Motors at Collieries.—At the quarterly meeting of the South Wales Institute of Engineers, held on Saturday at Cardiff, Mr. Sydney F. Walker dealt critically with suggestions as to improved winding appliances at collieries. Mr. Walker argued that it would be more economical to wind by means of electric motors than by steam engines.

Electricity at a New Zealand Exhibition.—The Auckland Industrial and Mining Exhibition is of considerable extent, covering a space of six acres. The machinery court contains a number of exhibits of mining machinery, and also a number of Crompton dynamos, exhibited by that firm's local agents, Messrs. Wm. Crosher and Sons, of Auckland. The machines in use consist of six dynamos of various sizes, giving a total output of 562 8-C.P. incandescent lamps, which are distributed throughout the building to the stands of the various exhibitors. The dynamos are driven by three of Crossley's Otto gas engines, and a Union Company's oil engine, totalling 30 available H.P. This is the most extensive electric lighting plant ever exhibited in Auckland (which we are given to understand is notably behind the times in electrical matters), and is a source of considerable attraction to the thousands of visitors to the Exhibition. The general lighting of the Exhibition is in the hands of the local gas company. It is to be hoped that this display will give an impetus to electric lighting in the district. Messrs. Wm. Crosher & Sons are also under contract to light up the Caliope Dock and the dock grounds for the North Shore Native Regatta and Maori Village, where native dances and other sports will be held.

Electricity in Boiler Works.—Messrs. Cochrane and Co., of Annan, are at present fitting up extensive works for boiler making on Newbie estate, at the mouth of the River Annan. The works are to be lighted and driven by electricity.

English Industrials, Limited.—We are given to understand that the "English Industrials, Limited," of 55, Market Street, Manchester, have bought from Messrs. Hummel & Helberger, of Munich, the sole rights for the United Kingdom and the Colonies of their Patent No. 13,594, which relates to all kinds of electrical heating apparatus, and they are now manufacturing the various specialities in connection therewith. These heating apparatus have had a large sale on the Continent, and we are informed that although Messrs. Hummel & Helberger have been working night and day, they cannot cope with the demand. For these articles an efficiency of 97 per cent. is claimed.

English Inventors and U.S. Patent Law.—Messrs. Fairfax & Wetter, of Essex Street, W.C., write to us as follows:—"An important decision affecting many English inventors was given by the Commissioner of Patents at Washington on December 20th. According to Section 4,887 of the new Statute, which became operative on January 1st, 1898, an inventor who had first applied for a patent in a foreign country will not be debarred from receiving a patent for the invention in the United States, by reason of its first having been patented abroad, unless the application for said foreign patent was filed more than seven months prior to the filing of the application in the United States. Now, as the majority of inventors in England file a provisional specification, and obtain provisional protection before they file a complete specification, on the base of which the patent is granted, a few experts had arrived at the conclusion that, in the case of the English patent the date of application referred to in the said Statute would be the date of filing the complete specification. On December 20th, 1898, the question came before the Commissioner of Patents, who held that the date of application for an English patent is the date on which the original application was filed, even if it had been accompanied only by a provisional specification, the reason being that, according to English law, provisional protection is not analogous to a caveat, and the patent, when granted, is dated as of the day of application, instead of bearing the date of the actual grant or issue, as is the case in the United States and some other countries. English inventors must, therefore, be careful to apply for a United States patent in good time, if they wish to obtain protection for their invention in the United States."

The Geipel Steam Trap.—We have received from Messrs. Geipel & Lange a description and drawing of their steam trap, which is one of the variety which works by the expansion of metal by temperature. In the Geipel trap, however, this expansive action is multiplied in a peculiar manner. Two pipes of some length are rigidly connected by a stout base piece to form two sides of an approximately isosceles triangle. By differentially heating these pipes, and one of them is of brass so as to expand differently from and more than the other pipe of iron, the triangle becomes scalene and its apex moves through some little distance. This movement is the greater as the bases of the pipes are near together and is a multiple of the actual difference of the two pipes, and it is from this apex movement that the escape valve receives its movement. Cooling of the lower or brass pipe by the accumulation of water pulls open the valve, which allows of the trapped water being blown through. As the water escapes the brass pipe quickly becomes hot and shuts the valve, and it is claimed that not only is the action secured very efficient and certain, but that by a suitably arranged spring the trap is adjustable for different boiler pressures, and is also suited for varying pressure as demanded by the Admiralty from the atmosphere up to 300 lbs., or, in other words, they demand a trap which, while tight for steam from 220° to 420°, shall nevertheless discharge water at 410°. These conditions are ingeniously secured by an adjustable valve stop controlled by a diaphragm exposed to the steam pressure, and so connected through a spring and lever as to suit the valve stop to the high or low temperature position of the apex.

Installations at Wrexham.—Mr. William Sillery, of Wrexham, has just completed a number of lighting plants locally. These include a plant for 500 16-C.P. lamps for the Cobden Flour Mills Company. Here there is one spare dynamo, and an additional machine for day load. Messrs. Davies Bros. have had a plant for 100 16-C.P. lamps put in for lighting their terra-cotta works and offices. Mr. Sillery has also put a telephone system into Messrs. I. M. Jones and Sons' Cambrian Leather Works and offices.

Joyce v. Killarney Electric Light Company.—At Killarney Quarter Sessions, on Friday last, Mr. W. H. Joyce, electrical engineer, sued the Killarney Electric Light Company for £35 for money paid for their use and account. Mr. Joyce, upon being sworn, stated that in the year 1895 he entered the employment of the defending company as their electrical engineer, and that in the year 1896, at the request of Mr. C. E. Leahy, the managing director, he collected the rents due for the electrical current and also used to pay the workmen. In December of last year he left the employment of the company, and on balancing the books he found he paid £35 on behalf of the company more than he actually received. He admitted that he received moneys without accounting for them. For the defence, Mr. Maurice Moriarty, the secretary of the company, was examined. He stated that he had examined the books kept by the plaintiff and

that the balances were erroneous; that instead of the company being in debt to Mr. Joyce by £35, Mr. Joyce was £4 indebted to the company. Mr, Moriarty admitted that at times they were very hard pressed for money, and that Mr. Joyce used to advance various sums from his private account for the purpose of paying urgent demands. He also admitted that the moneys collected for the Electric Light Company were sometimes lodged to the credit of Mr. Leahy's county cess account. He further admitted having collected moneys himself and given them to Mr. Leahy, the managing director. His Honour, in giving judgment, said it was no wonder that the company was not in a prosperous condition, considering the unbusiness-like way its affairs were managed. He directed the clerk of the peace to audit Mr. Joyce's books. Upon getting the report he would give his decision at the next Tralee Sessions.

Large Order for Babcock Boilers.—We understand that what is probably the largest order for stationary boilers ever given was placed during the month of December with the Babcock and Wilcox Company, in New York, by the Westinghouse Electric Company, of Pittsburg, for 60 boilers, each of about 1,000 I.H.P., or a total of 60,000 I.H.P.

New Business.—Messrs. Offord, Wilson & Barfield have commenced business as electrical engineers and manufacturers at 97 and 98, Woodcock Street, Birmingham. The firm will make arc lamps, stage arcs, measuring instruments, switches and switchboards, &c.

New Copper Wire Works in Bohemia.—A new company is in course of formation at Prague with a capital of 1,200,000 kr. to establish large new works for the production of copper wire for telephone and telegraph purposes.

Newspaper Directory.—"Street's Newspaper Directory" for Great Britain and Ireland, for 1899, is now before us, and from a number of references we have turned up, it seems to be a reliable index to the press of the United Kingdom. Maps are given at the front of the book. It is published at Street's Foreign and Colonial Advertising Offices 5, Serle Street, W.C.

Receiving Order.—At the Birmingham County Court on Saturday, a receiving order was made in the matter of Thomas Ford, chandelier and electric fittings manufacturer, carrying on business at Victoria Works, Emily Street, Highgate, Birmingham, trading as Thomas Ford & Co. Mr. A. J. O'Connor, of 25, Bennett's Hill, is solicitor in the proceedings.

Release of Trustee.—Notice is given of the release on September 29th, 1898, of trustee (Mr. W. A. Smith, of Manchester) in the case of C. L. Clarke (Northern Counties Electric Construction Company, of South Parade, Manchester).

South African Electrical Notes.—The current issue of the *British and South African Export Gazette* says that considerable shipments of arc and incandescent lamps have been made during the past month to Lourenço Marques for the electric lighting of the town, for which the General Electric Company, Limited, London, have secured the contract.—A 175-kw. dynamo, for power and lighting purposes, is on order for the Roodepoort Central Deep mine.—It is under consideration to light the streets of Boksburg (Transvaal) by electricity.—The Durban Town Council have decided to instal a complete system of telephonic and electric fire alarms in the town.

St. Louis Car Company.—Messrs. Warburg, Dymond and Co. inform us that they have been appointed agents for the United Kingdom to this company, and are prepared to negotiate with engineers, contractors, and others for the supply of cars and trucks for electric tramways and light railways. This company's cars are largely in use throughout the States and the Continent. The St. Louis Car Company are prepared to build cars to any specification or design.

1898.—Mr. Geo. Stegmann reports that during 1898 his business turnover has more than quadrupled. He is exceedingly busy at the present moment.

ELECTRIC LIGHTING NOTES.

Aberystwyth.—Last week it was stated to the Harbour Committee that a party has taken a mine in the neighbourhood for 40 years, and is to spend £20,000 upon putting in electric light, &c.

Acton.—The District Council will accept a supply of electricity from the Metropolitan Electric Supply Company's works at Willesden, if satisfactory terms are arranged. The offer of the company is 3d. per unit for seven years.

Alloa.—The installation of electric light into Kilncraigs Factory (Messrs. J. Paton, Son & Co.) is now completed, and the whole of the large manufactory, including the mills, stores, offices, warehouses, &c., is lit with this illuminant. Three combined dynamo-engine sets by Willans & Robinson and Siemens Bros., Limited, are employed, developing 180 amperes each at 200 volts, while in connection with these there are two 10-H.P. engines (working a condensing plant) supplied by the Glenfield Company, Kilmarnock. The wiring throughout the building was fitted up by Messrs. Lowdon Bros., Dundee, and the lighting is effected by no fewer than 1,300 16-C.P. incandescent lamps. The dynamos also supply power for a 60-H.P. motor by Mavor & Coulson, Glasgow. Messrs. Burstall & Monkhouse were the consulting engineers.

Ayr.—With reference to a recent partial failure in the electricity supply, the Council on 9th inst. had a discussion as to the cause. It was explained that cables were very susceptible to damp, and the recent heavy rains were responsible. The resident engineer, Mr. Fuller, had reported that if there were another sub-station in Racecourse Road the breakdown would not have occurred. Mr. Fuller reports that the maximum load reached last year was 206 kw., as against 140 kw. in the previous year.

Barmouth.—Mr. D. Davies having signified his intention to apply for a provisional order, the Council has arranged to oppose.

Barnet.—In the *London Gazette* for January 17th the District Council gives notice of intention to transfer its 1893 provisional order to the North Metropolitan Electrical Power Distribution Company, Limited. The company pays the Council £227 for costs incurred in obtaining the order. The company will light the High Street with 14 500 to 600-watt enclosed arc lamps, and the remaining streets with 164 columns supplied with 16 C.P. incandescent lamps.

Barnsley.—The Local Government Board has sanctioned the £25,000 electric lighting loan, and the foundation stone of the works will be laid in about six weeks.

Bermondsey.—The Electric Lighting Committee reported to the Vestry at the meeting on Monday the receipt of a letter from the Board of Trade enclosing draft of amended form of consent to an extra high pressure supply being given by the London Electric Supply Corporation. The letter also covered an amended description of the system to be adopted by the company for the supply of energy in the form which the Board proposed to approve, and the Board of Trade asked whether the Vestry desired to make any observations on the subject. As the Committee found the question to be of a highly technical character, they recommended that Mr. Fred. Ryall, the vestry clerk, should consult with Mr. Manville, and report to the Board of Trade any suggestions which he might have to offer. In the absence, however, of Mr. Manville abroad, the clerk had informed the Board that the Vestry had no observations to make on the subject. The General Purposes Committee announced having received a letter from the Westminster Vestry on the subject of underground electric railways in London. The Vestry pointed out that they had asked the London County Council to oppose the North-West London Railway scheme for an electric line along Edgware Road, and the Great Northern and Strand Railway for a line from Wood Green to Stanhope Street, Strand. Having considered the letter, the General Purposes Committee reported that they had taken no action in the matter.

Bettws-y-Coed.—Mr. Peers, electrical engineer, Colwyn Bay, attended a recent Council meeting, and stated that electricity could be brought from Llanrwst, and that the price of lighting the street lamps would be £1 for 500 hours. It was decided to ask Mr. Peers to submit a tender in writing, and to consult a parish meeting.

Bournemouth.—At a meeting of the Town Council held last week the draft provisional order was read and approved. The surveyor was instructed to prepare estimates for deposit with the order, and, if necessary, to consult an electrical engineer. The above order is in connection with the recent decision to undertake the electric lighting of the Pier, Pleasure Gardens, &c.

Brecon.—The Gas Company wants to raise the price of the street lighting, but the Town Council will not pay the increased rate. At the last Council meeting, when the matter came up, the mayor remarked that he had given strict orders to have the electric light plant put down for the purpose of lighting the town by electricity as soon as possible.

Bristol.—At their last meeting, the Bristol Electrical Committee considered the appointment of an assistant in-door engineer at a salary of £175. There were 86 applicants for the berth, and several appeared before the Committee, who selected Mr. A. G. Bird, who has had experience with the Yorkshire House-to-House Electrical Company, the Taff Vale Railway Company, the City and South London Railway Company, and the Cardiff Corporation. Reference was made to the near prospect of a further extension of the electrical station on account of the rapid and continuous growth of the demand for private lighting. There are now 64,000 lamps actually connected to private customers, the orders on hand raise the number to 71,000, and the extended station would be equal to 80,000. During next year it was felt that a further extension must be entered upon. Statistics showed that five years ago there was a demand for 7,000 lamps; in 1894 the number was 11,372, and in 1895 it amounted to 19,453. Between December of 1895 and March, 1896, it increased to 24,000, and this advance has since gone on at the rate of 14,000 lamps a year. Revenue has also increased. At the end of 1893 the sale of current in the five months the works had been open, produced £1,345; in 1894, £6,452; in 1895, £9,834; in 1896, £14,845. Then the financial year was altered, so as to end in March, and for three months of that year the income was £5,491. For the full year ended March, 1898, the revenue was £20,133.

Bromley.—The District Council have received a claim for £10 damages for injury done to a van by it sinking in the ground at Widmore Hill, owing to the bad condition of the roadway, caused, they suggest, by the road not being properly re-laid after it had been opened to receive the mains. The Council say that such claim ought to be made upon the Electric Light Company.

Burton.—The Town Council will oppose the Leicestershire and Warwickshire Electric Supply Company, also all other large power schemes proposing to compete with municipalities.

Bury St. Edmunds.—The Local Government Board has sanctioned the borrowing of £15,250 for electric lighting, to be repaid within 25 years. It is expected that the Council will have the installation completed by the end of the year.

Cardiff.—An independent expert is to advise the Workhouse Building Committee upon the lighting of the workhouse by electricity.

The Corporation is inviting tenders for the extension of the electric light station buildings in Eldon Road.

Castleton.—The District Council will oppose the Lancashire electric power scheme.

Chatsworth.—On the occasion of the recent ball, for which 500 invitations were issued, a number of additional electrical effects were introduced. In the ballroom two large sprays, each consisting of 25 lights, were much admired, and upwards of 200 lights were fixed for the frieze lighting and side clusters to balance the shadows. In the statuary a large centre piece was fitted with palms and foliage of different kinds, amongst which lamps were hidden so as to produce a glow-worm effect. In the orangery, used as a supper room, a large number of coloured lamps were arranged amongst the palms. Although a very great tax was put upon the generating plant, it was found capable of supplying all the additional current, the full output being maintained for 12 hours without cessation. The arrangements were entrusted to Messrs. Drake & Gorham, who laid down the original installation.

Chesterfield.—The Council has asked the Watch and Lighting Committee to consider the advisability of providing a generating station for supplying electricity.

It is interesting to note, says a correspondent, that Chesterfield was one of the first towns in the country to be lighted with electricity. On October 8th, 1881, the streets were lighted by electricity by the Brush Company, but after two years, the experiment not being a success, gas lighting was re-introduced.

Chichester.—Several prominent residents are advocating the introduction of electric lighting. The Council has discussed two or three schemes brought up by the surveyor, but it is felt that more information is necessary.

Chislehurst.—It is stated that the work of laying the mains from Bromley to Chislehurst has been completed, and that in a few weeks' time the electric light will be fully installed in the village.

Coatbridge.—The Scottish House-to-House Electricity Company, Limited, has given notice of intention to proceed with several draw boxes at different points in the town.

Cork.—Mr. Ashdown (consulting constructor to the Admiralty) arrived at Queenstown some days ago with reference to the proposed lighting of Haulbowline by electricity. Haulbowline has of late received considerable attention from the Government, and large sums are being spent on the improvement of this once noted dockyard. Rear-Admiral Lake accompanied Mr. Ashdown, and steps were taken regarding specifications, and arrangements made to prepare plans, &c., for the electric lighting of the island. The illumination of the docks, fitting shops and wharves, will probably be taken in hand first. The work will be offered for contract.

The electric tram system is in excellent working order, and is largely made use of by the public. Our local correspondent says that the public electric lighting, which was expected to be in operation on January 1st, is not yet completed, owing to some experiments which are being made relative to the size and class of lamps to be used. It is hoped that by February 1st, at latest, the new street lighting will be in operation.

Croydon.—At a meeting of the Croydon County Council on Monday the Lighting and Electricity Committee reported that they had had under consideration reports and estimates for the extension of plant at the electric light station for further public lighting and low tension main extensions, and for further arc lamps. The extensions recommended were necessary for next winter's supply. As to the additional arc lighting, it was proposed to extend this in various districts by means of 79 lamps. The Committee recommended, however, that provision be made for 100 lamps, to allow a margin for other extensions. The estimates for these works were as follows:—Station extensions—500-kw. steam alternator, £5,200; pipework, switchboard, and rheostats, £540; two boilers and piping, including brickwork, £1,970; one water softener and connections, £260; new cooling pond, pipework, and sprays, £600; new battery and connections, £740; new pump, £210; extension to stores, £160; new hot well, £110; total, £9,790. Public lighting and low tension main extension, including transformer chambers and £1,500 for house services, &c., £8,264; 100 lamps and posts complete, with switch gear, labour, cable, &c., £3,483; contingencies on the whole of works, say, £463; total, £22,000. The Committee recommended that application be made to the Local Government Board for power to borrow £22,000. The town clerk said that with the amount of the present estimate, the sum applied for and loans sanctioned, the amount would come to nearly £100,000. After discussion, the recommendations of the Committee were adopted.

Devonport.—When the Devonport municipal electric lighting scheme gets under weigh one of the first claims upon it will apparently be that of the lighting of the districts of St. Budeaux and Pennycross, which have recently been added to the borough. The borough surveyor is to report upon the question of supplying the electric light there.

Last week the Town Council adopted a recommendation of a committee that the Fitzroy Road site for the electric lighting station be approved.

Dover.—Last week Alderman Baker brought forward a suggestion that the Council purchase the gas works and also the electricity undertaking. The Electricity Company were about to issue more capital, and he thought it was time for the Corporation to seriously consider the question of purchase. The Mayor, who happens to be chairman of the Electricity Company, said that years ago he begged the Council to carry out the electric lighting powers. The Council refusing, he got someone else to take the matter up, with the result that the company had spent about £80,000 at Park Street and in the streets of the town. A large block of their shares were sold the other day at 20 per cent. premium, and no doubt they would soon stand at 100 per cent. premium, so that the Council would have to pay £10 for £5 shares. After discussion the matter was left over for further consideration at the next meeting.

Dublin.—We read in the Dublin papers that electrical engineering contractors in the town are exceedingly wroth because contracts amounting to something like £6,000, in connection with the changing over to high voltage, have had to be given to English firms. They have banded themselves together and formed an association for the protection of their interests.

Edinburgh.—Last week the Town Council discussed a resolution, of which notice had been given by the Lord Provost and Bailie Mackenzie, to remit to the Lord Provost's Committee to take steps for having inserted in the new Parliamentary Bill a provision empowering the Corporation, if they think fit, to form out of the revenue of the electric lighting undertaking a special fund for the purpose of meeting substantial renewals of plant and machinery, which shall be in addition to the statutory reserve fund. The Lord Provost, in moving the adoption of the resolution, pointed out the difficulties which existed in regard to providing for renewals. He believed that if they went to Parliament to get this power, the Board of Trade would not object to it. Bailie Hay seconded. Mr. George Auldjo Jamieson moved that the motion be not adopted. Mr. Williams seconded. Treasurer M'Crae moved that the matter be remitted to the Electric Lighting Committee to draw up a report and lay it before the Council. The latter amendment was adopted, and a committee will therefore go into the question.

Exeter.—Whatever may be the ultimate decision with reference to the application of electrical traction to the city tramways, the Corporation of Exeter will find it difficult to postpone for any length of time the serious consideration of the question of removing the electricity works to another and better site. In the days of the old company it was complained that the present site was inconvenient. Before the Corporation took over the works, they were advised that the position was so cramped, that extensions would be practically impossible, and were warned that it would be necessary before long to remove the plant to a place which would afford more elbow room, as well as greater facilities for carrying on the undertaking. Since then the business has greatly increased. The Corporation have not only introduced the electric light into the streets, but the number of private consumers has doubled. A necessary result of all this is that the pressure upon the old station has increased, and some of the ill effects are being experienced by the residents in its immediate neighbourhood. A memorial presented to the City Council last week by owners and occupiers of property near the works, complained of increasing noise and vibration, as well as of the smoke emitted from the chimney. The city surveyor and the electrical engineer have been for some time past considering what methods can be adopted to increase the capacity of the works. It is suggested that the simplest plan would be to select a new site.

Fulham.—The Electric Lighting Committee last week considered several points in regard to the electric lighting scheme. Mr. Medhurst, the consulting engineer, has reported upon the question of providing a water supply for the electric light station. He recommended that two artesian wells be sunk, and that tenders for the work be invited. The engineer's plans as to mains have been approved. He is to prepare rules and regulations for wiring, &c.

Gillingham.—The District Council is asking the local electric light company if they could reduce the charge for the proposed lighting of the High Street. The relative costs at the present rates are, gas £116 15s. and electric light £186 5s. 9d. per annum. A Sugg's lamp costs £11 10s. annually, and an electric light would cost £26 12s. 3d.

Glasgow.—Mr. Chamen reported to the Electricity Committee last week that the 750-horse-power engine, supplied by an American firm, had been erected at the Port Dundas station, and was in the meantime being used to augment the supply from the power station in Waterloo Street. The extra current thus at their command had enabled them to remedy the complaints of consumers who had been liable to have their light supplied only intermittently. The 400 and 300 horse-power engines, by Messrs. Mirrlees, Watson & Yaryan, and the 900-H.P. engine by Mr. Matthew Paul, are now being fitted up at Port Dundas, so that in about a month they would have altogether engines of 2,250 horse-power combined running there. They will then be in a position to turn on the electric lights on the Springburn tramway route. The Committee gave Mr. Chamen authority to spend from £50,000 to £60,000 in new mains and feeders for the supply of electricity to districts already agreed upon, and to advertise for

tenders for the machinery still required for Port Dundas and Pollokshaws power stations. A committee was appointed to obtain information as to the supplying of electric motors of all sizes to the public.

Grays.—The Grays Urban Council have adopted the scheme of Mr. A. H. Preece, the engineer, for lighting the town with electricity. The plant, which is to be made to include a dust destructor, will comprise two boilers, two engines, and two dynamos.

Grimsby.—Last week the Town Council adopted the report of the Lighting Committee, and will proceed to lay down works for generating electricity for lighting and tramway purposes. Application is to be made for a loan of £43,500, to be paid back over 40 years.

Hammersmith.—In a report submitted to the Vestry on Wednesday, the electrical engineer, Mr. G. G. Bell, expressed the opinion that a large saving of time and cost would be effected by the Vestry employing a main-laying staff, and laying its own mains. He estimated the profit at about 3d. per yard. The Vestry decided that the proposal be tried in six important roads, the cost being estimated at £13,000.

At a meeting of the Law and Parliamentary Committee of the Hammersmith Vestry on Tuesday, the Kensington and Notting Hill Electric Lighting Bill was discussed at length. Ultimately it was decided that as there seemed to be a reasonable opportunity for obtaining the long wished for communication between Latymer Road and Wood Lane, they should advise the Vestry, while petitioning against the Bill for obtaining the necessary *locus standi* for protective clauses, to instruct them (the committee) to endeavour to see that the subway was of sufficient height for the accommodation of the traffic and dedicated to the public use.

Hampstead.—The electrical engineer, Mr. Cottam, informs us that the actual units generated on this station for the year ending December 31st last are:—

Alternating	1,005,450
Public lighting	77,051
Used on works	12,000
Total	1,094,501
Approximate capital expenditure to December 31st, 1898	£119,396
Total number of applications	1,237
" consumers connected ...	1,181
" lamps connected	78,091
" transformers, equivalent to kilowatts	1,113

Consisting of 34 of 25-kw., nine of 18-kw., four of 10-kw., three of 6-kw., four of 4-kw., nine of 3-kw.

The Guardians' Finance Committee has ordered that the necessary electrical fittings be fixed for heating a new electrical radiant heat bath which the inventor has offered to lend on condition that the medical officer keeps a record of the cures effected by it.

Hanley.—The Council has decided, in consequence of the resignation of Mr. Sutherland, joint engineer with Mr. Cowell, to appoint the latter gentleman Corporation electrical engineer, at a salary of £250 per annum. Mr. Lobley will continue to act as engineer for capital expenditure, and consulting engineer on revenue account; and two junior assistant engineers are to be engaged for the electricity works at £80 a year each. In future any new distributing mains required in the district outside the compulsory area will be arranged for a pressure of 200 volts at consumers' terminals, and the existing mains will be converted from 100 volts to supply 200 volts as may be convenient. From the 1st inst. the charge will be 5d. per unit up to 150 hours of the maximum demand indicated, and 2½d. per unit for all beyond.

Hartford.—The Parish Council has decided to light the public streets electrically, current being obtained from the Northwich Electric Supply Company.

Hastings.—The town clerk, Mr. B. F. Meadows, has handed over a cheque for £58,000 to the secretary of the Hastings Electric Light Company, this being the sum agreed upon for the purchase of the company's undertaking.

Islington.—The Guardians have appointed Mr. Enright to report on the cost of an electric light installation at Highgate Hill.

Lancaster.—A Local Government Board inquiry was arranged for yesterday *re* the proposed £10,000 loan for electric lighting.

Leeds.—The Lighting Committee has decided to extend the mains along North Street and Chapel Lane, Headingley.

Llandudno.—Some days ago the "formal opening" of a Beaman & Deas refuse destructor took place at the electricity works. The destructor is constructed to deal with 60 tons of refuse per 24 hours. The cost was about £7,000, the electric lighting part amounting to £23,000

London.—The St. Giles's Board of Works last week decided, as the Charing Cross and Strand Electricity Corporation are so dilatory in opening and closing the public streets, thereby causing considerable inconvenience, that the Board would itself open the trenches necessary for the laying of the mains, and restore and make good the paving afterwards. It was thought that this would ensure the work being done more expeditiously. The Vestry appointed a committee to report upon the desirability of applying for a provisional order.

At the St. Luke's Vestry, on Tuesday, the General Purposes Committee reported that they had reconsidered the application of the Smithfield Markets Electric Supply Company, Limited, for a provisional order for the supply of electricity to the parish. Having considered reports by the solicitor to the Vestry, and the surveyor, it was resolved to withhold consent to the application.

Lowestoft.—Mr. Hawtayne's estimate for the electric lighting of the town (including the cost of provision for extra mains, culverts, and a larger generating station for the light electric railways) is £26,000. Mr. Hawtayne is advertising for tenders for the work before application is made for a loan. A deputation will visit Brighton to examine and report as to the system of charges in force there.

Merthyr.—The Council last week considered a report from Messrs. Handcock & Dykes, electrical experts, on the scheme for the proposed electric lighting of the town and district by the British Electric Traction Company. It was agreed that, subject to the company laying mains throughout the whole parish within a period of four years, the Council adopt the report as a basis of the conditions on which their support should be given to the provisional order.

Mull.—A water-power electric lighting plant has been put down at Aros House, Tobermory, by Mr. R. F. Yorke, of Glasgow. The water-power is derived from Loch na Meall, about a mile away.

Newcastle.—The Newcastle Electric Supply Company have under consideration the question of supplying continuous current for motive power purposes throughout their area. They have now undertaken to supply such current for driving an Otis passenger lift and large ventilating fans, &c., in the Y.M.C.A. new Shaftesbury Buildings at present erecting. The Otis Elevator Company is putting in the lift, and the fan motors are to be supplied by Messrs. Bland Bros., of Newcastle. The same building will be lighted by over 500 incandescent electric lamps.

Newport.—The Alexandra Dock Hotel Company intends extending its private electrical installation so as to include the whole of the dock area.

Newport (I.O.W.).—The Council has arranged terms of agreement under which it allows the Ventnor Electric Light and Power Company to apply for a provisional order.

Nottingham.—A Local Government Board inquiry was held on 11th inst., *re* a proposed Corporation loan of £150,000 for electric lighting. The town clerk stated that a previous loan of £85,000 had been expended, and the Council could not keep pace with the demand for electricity. The city engineer (Mr. Arthur Brown) was questioned as to plans for the new buildings, stating that the builders' contract was £24,000. Mr. Talbot, electrical engineer, said that there were at present between 14 and 15 miles of mains, and after this extension the length would be about doubled. There were 15 street lamps already in use, viz., in St. Peter's Square and the Market Place. £16,000 had been allowed in the new scheme for street lighting, providing for 160 arc lamps. The present horse-power amounted to 2,200, which would be increased to 6,300. The system in use was known as the three-wire, low pressure, continuous current system, which was approved by the Board of Trade in 1895. At present the Corporation had 780 customers using electricity, some utilising it for lighting and some for power. It was in 1894 that the installation took place.

Ogmore Valley.—The seal of the District Council has been affixed to a contract with the Ogmore Valley Electric Power Supply Company, Limited, for the lighting of the Ogmore Valley.

Oldham.—In connection with the proposed electrical extensions, a joint meeting of Corporation Committees last week considered the question of an additional plot of land upon which to extend the works.

Paddington.—On Tuesday, at a meeting of the members of the Paddington Vestry, the Rev. Walter Abbott, M.A., J.P., chairman, presiding, a report was received from the Electric Lighting Committee recommending that the solicitor be instructed to take the opinion of counsel as to the powers of the Metropolitan Electric Supply Company under existing Acts to lay down trunk mains or any other lines through the parish for use in other parishes or otherwise. Colonel Barchard, the chairman of the Electric Lighting Committee, in moving the adoption of the report, said that it was found that the company intended to lay down five large cables through their streets, each cable having the pressure of 10,000 volts, so with five cables there would be 50,000 volts, and these were to be taken from Willesden through their parish to other parishes, and it was a most important question to be decided, whether the company under its Act had the power to do such. They had to consider the matter seriously, because if in the future the Vestry desired to purchase the company's undertaking, so far as it related to this particular parish, it would become a serious matter for consideration. They knew perfectly well that when the order was applied for, and they gave their consent for the company to lay mains, &c., to supply the parish with electricity, that certain powers were given, but whether the company had power to lay down trunk mains, &c., that they could for the purposes of supplying other districts from their generating station at Willesden, was a question they desired

counsel's opinion on. Mr. Williams, who seconded, considered that it was important that action should be taken at once, because he understood that the company intended to proceed with the work as quickly as possible. Colonel Barchard said that the committee had taken action to prevent the work being proceeded with without the consent of the Vestry. The recommendation was unanimously agreed to. Mr. Whur moved that the committee have power to act so that delay was not occasioned, and this was at once agreed to. Mr. Frank Detheridge, the vestry clerk, read a letter he had received from the Metropolitan Electric Supply Company stating, in reply to the Vestry's letter, that they are unaware that any of their obligations under the order of 1890 remains unfulfilled, and that testing stations have been established for the company's own requirements, at which also the County Council inspector is at liberty to test the supply of energy at all reasonable hours as provided for under the order. Sir George Fardell, M.P., said that he thought that it would be well if the committee, whilst they were taking counsel's opinion in regard to the powers of the company to lay down trunk mains, also took opinions as to the company's obligations and the powers to enforce them to carry out their obligations, some of which he contended they had still not done under the order of 1890. There were many streets that were scheduled for the mains to be laid down which had not been done, whilst streets not scheduled had mains put down. They heard now that the company had testing stations for their own requirements, but he contended that what was required was that there should be testing stations away from the company's premises, so that if a consumer was dissatisfied with the energy he received he could go and have the same tested. Colonel Barchard considered that the letter should be referred to the Committee for action. It was idle to state that the company were not fulfilling their obligations, because the Committee knew that they were, and if any obligations were not being carried out he could tell them the Committee called attention. They knew that there was 281 miles of streets scheduled, and that in 24 miles of streets the company had laid their mains. There were streets that were not scheduled where mains had been laid, and several streets that were scheduled where mains had not been laid, simply because they were unimportant streets and there had been no demand made upon the company for the supply of electricity from the inhabitants of such streets, or else they would have under the order been compelled to lay down in such streets. It was no use their calling on the company to go to a very enormous outlay in laying down the plant in streets that it was not required, because if they did the effect would be that the ratepayers would not get the advantages that they now did in having the electric light supplied to them at a cheap rate. Much had been said about the company getting supplies from other districts; well, that was all the better. At Amberly Road station they had sufficient power to supply the whole of Paddington. There was one advantage in their being connected with other stations, because if there should be an accident—say at the Amberly Road station—then they could be supplied from the other stations. Several members having spoken on the subject, Sir George Fardell, M.P., withdrew his motion to refer the question of the company's obligations to the committee to take counsel's opinion, and agreed to a resolution that the letter be referred to the Electric Lighting Committee with power to act.

Paisley.—In reply to a query as to when the electric light would be available, ex-Bailie Fisher said all the engines were on the ground, and were now being erected. They could put the current on this month, but it would be unwise to do it until they got all their machinery in order.

Penzance.—It being the intention of Penzance Town Council to oppose the application of the Edmundson Electricity Corporation for a provisional order to light Penzance with electricity, the company have written to the Council expressing the hope that they will, on further consideration, arrange terms. The suggestion having been made at a recent meeting of the Council to erect a dust destructor in connection with the electric lighting works, the company pointed out that such an arrangement in a town like Penzance could never possibly answer, as a site which would be suitable for a dust destructor would involve very heavy expenditure in connection with the electric lighting plant. No town in England of the size of Penzance had ever yet been able to make electric lighting pay within the first two or three years, so that it would be absolutely certain to involve an addition to the rates for some time to come.

Portsmouth.—At the last meeting of the Town Council, the Electric Lighting Committee recommended that electric mains be laid in Thomas Street, Landport; The Thicket, Southsea; and Highland Road, Southsea.

Prestwich (Manchester).—At the last meeting of the Urban District Council it was decided to request the local representatives in Parliament to oppose the scheme of the Lancashire and Cheshire Electric Supply Company.

Queenstown.—The Board of Trade has sanctioned the transfer of the provisional order granted to the Town Commissioners to the Cork Tramways and Electric Lighting Company. Work will be commenced immediately. In less than a year Queenstown will have electric light.

Radcliffe.—The District Council have applied to the Local Government Board for permission to borrow £16,000 for electric lighting purposes. The consulting engineer made inquiries, and found that three firms are willing to take over a concession respecting electric traction from the Council on equitable terms, and he has advised the Council to accept the best offer. He is of opinion that the current required for working the tramways alone would almost pay the working expenses of the electric lighting station if supplied to a company at, say, 1½d. per unit All doubts of the electric lighting station paying a handsome profit would then be at an end.

Rhyl.—The Council proposes to spend £10,000 upon electric lighting. Application is being made for a provisional order.

Saltburn.—It was mentioned at a recent Council meeting that Mr. Cox-Walker, of Darlington, had written to residents saying that he was now engaged in laying down a plant for the supply of electric light to private houses and other buildings in Saltburn, and if the recipient of the circular wished to take a supply he would be glad to receive an application, so that arrangements might be made before April.

San Paulo.—We are informed that the San Paulo Gas Company have decided to at once erect an electric light plant for the supply of current for lighting and power. They have already entered into an agreement to light the new railway stations in course of erection in San Paulo. The gas company has decided upon this because of the strong position they occupy in San Paulo with the new concession for 30 years, and being in a position to raise the capital without difficulty. The company's consulting engineer has been instructed to prepare the plans and specifications, and obtain tenders for carrying out the work with the least possible delay.

Sheffield.—The new Electric Light Committee having taken possession of the electric light works, have found that the requirements of the consumers make it necessary to work the machinery at its full capacity; they have no spare machinery whatever. That state of things, says Alderman Styring, must not continue. The company had been exerting themselves for some time past to remedy this state of things, and new and powerful machines had been put down. He referred to the 300-kilowatt and the 600-kilowatt machines, which machines ought to have been fixed and in working order by the end of 1897; but owing to the engineers' strike, the company were unable to obtain the machines, and they were not actually got to work until two or three months ago. When they were put to work it was found they would not yield the power which they were guaranteed to produce, and they would at once have been taken in hand and put in order, only the demand for power was so great, that it was necessary to get as much power from them as possible, in order to keep the undertaking going at all. The intention now was that the machines should be taken in hand as soon as the days lengthened, and there was less demand for power. The Council might rely upon it that the committee would do all that was possible to make the machinery adequate. Machines were ordered, and were in course of being delivered, and there was no doubt that in the course of the present year matters would be put in such a position, that all requirements would be duly met. The recent failure in the supply was due to a short circuit behind the switchboard. Members of the Council would probably like to know a little of the undertaking which they had taken over. The lamps wired during the last year were 17,865, as compared with 13,565 lamps wired in the previous year. That was an increase of lamps wired of 22 per cent., and brought up the total lamps to 73,853. Approximately, the number of lamps wired last year was a third of the total previously wired. The current sold during the year was 978,086 Board of Trade units, compared with 738,499 the previous year, being an increase of 32 per cent. Turning to the finances of the undertaking, they would remember that the old company were empowered in the agreement to carry on the undertaking during the last year on behalf, and for the benefit of, the Corporation. The accounts of that carrying on were not finally completed, but they expected to have them very shortly. He was able to tell them, however, that the gross revenue for current sold and for meter rents during the year was £17,104 15s. 4d., as compared with £14,823 10s. the previous year. That was a very satisfactory increase indeed—nearly £2,000—and especially satisfactory when they remembered that the price of the current was in March last reduced from 5d. to 4d., notwithstanding which the revenue had overtaken and even exceeded the previous year's. One of the conditions of the carrying on was that the company should receive 10 per cent. interest on its capital, and that interest had absorbed the sum of £9,712 6s. 6d. In addition there was also to be paid out of the revenue the debenture interest, £1,125, making a total payment out of the revenue of £10,837 6s. 6d. for the year. He believed that there would be, after making the payments he had mentioned, a sum of no less than £3,000 clear profit on revenue account for the Corporation as the result of last year's working. Under the agreement, by virtue of which the undertaking was taken over, the Corporation were not to commence a sinking fund at any rate until the present year, so that they were in the position of having £3,000 (or whatever the amount might come out at exactly) with which to commence the working of the undertaking. In regard to the future policy of the committee, the first thing to be done was to make the plant perfectly satisfactory. The next thing would be to make the supply as cheap as possible to consumers, so that the public might have the full benefit of the light; and in the third place, whatever the committee could do after that in the way of making profit for the benefit of the coffers of the Corporation they would be very glad to do.

Shirebrook.—It is stated that the Shirebrook Colliery Company has brought forward a proposal to light the parish electrically, a company being formed for the purpose.

Southport.—The Council will offer a determined opposition to the Bills now being promoted by the Lancashire Electric Power Company and the South-west Lancashire and Cheshire Electric Power Company.

(*Continued on page* 93.)

BUFFALO ELECTRIC LIGHT AND POWER PLANT.

By ORRIN E. DUNLAP.

The Buffalo General Electric Company have commenced the use of Niagara power in the station especially planned and constructed for this purpose, and thus another milestone in the successful march Niagara power in making Buffalo and her industries captive to its benefits has been passed. The Buffalo General Electric Company has Daniel O'Day for president; George Urban, jun., as first vice-president; D. T. Nash is secretary; C. R. Huntley, general manager; and Henry G. Stott is the company's engineer. It was under Mr. Stott's supervision that the apparatus in the main building was erected, and it was he who designed the building and engineered the whole plant, which is so creditable to Buffalo enterprise, and ably marks Buffalo's progress in the use of the greatest power on earth.

The new plant is located on Wilkeson Street. Work on the buildings was commenced in March, 1898, and completed four months later. The main building is 91 feet × 91 feet 6 inches at the foundations and possesses many novel features of construction, everything about it having been planned and laid out to suit the apparatus to be installed, instead of the usual plan of designing the building first and then adapting the machinery, cables, &c., to the existing conditions. Working on these lines Mr. Stott has brought to perfection a plant which is a climax in his life's work in this country and abroad. The building is of brick, the main generator room being divided into two equal parts by a row of steel columns. These steel columns serve the double purpose of supporting steel beams for the two 10-ton cranes and the roof trusses. The steel trusses are also supported by the side walls, and resting upon them are I beams, which in turn support inverted T irons. On the flanges of the latter rest hollow hook tiles, the latter measuring 18 × 15 × 4½ inches. Upon this, after all joints has been cemented, was poured melted asphalt and roof pitch, with a double layer of roofing felt, and then more pitch and finally gravel. The result is a very fine roof, and the steel, being protected from sudden changes of temperature, does not sweat and drip on the machinery below. Fire walls are carried 4 feet above the roof, and the latter pitched in four directions, the water conductors being carried down inside the building to avoid trouble from freezing. The height of the main generator room below the trusses is 27 feet, and from the dome of the four large skylights 37 feet from the floor. The skylights are 18 feet × 8 feet, and each is so arranged that any side can be opened from the floor of the generator room. One side of the generator room has a row of windows protected by iron shutters. The floors of all rooms are brick arches covered with concrete and "mabbleithic" finish.

The transformer room is located in the rear of the main building. It has the same general construction as that mentioned, its dimensions being 51 feet × 25 feet 6 inches. Beneath the floor there is a brick air chamber into which motor driven fans deliver air at a pressure of about ½ oz. to cool the step-down transformers. Following the current as it comes in from the tile conduits in the manhole, we are led into a cellar 7 feet 6 inches high, through which are carried the three conductor cables carrying the 11,000-volt three-phase current from Niagara Falls. These cables rise to a loop panel, which has on it six double-bladed single-throw switches. These complete the loop in the two three-phase conductor cables, and also allow either circuit to be opened at this point in case of a fault in the cable beyond the transformer station, thus affording several advantages over the ordinary taps. From this panel the current goes to the time limit circuit breakers of the shunted fuse type, which are so arranged that in the event of a short circuit in either cable —both being in multiple all the time—the reversal of current in the one will cause the circuit breakers to set loose all apparatus in the station from the defective cable. Here it may be noted that similar arrangements are being installed in all the transformer stations of the Cataract Power and Conduit Company, so that in the event of trouble on one of the two circuits, all stations will automatically disconnect themselves from the faulty cable.

Leaving the circuit breaker panels we come to the transformer panels, four of which are installed to the left of the loop panels. Each of these panels contains six special high tension expulsion type fuse blocks and three high tension switches, and each panel supplies current to three 250-kw. step-down transformers, reducing the three-phase current from 11,000 or 22,000 volts to 352 volts, three-phase. These transformers are connected in groups of three to one panel, and both primary and secondary are wired single-phase to the switchboards, the delta connections being made on the panels after passing through the fuses, thus in case of a transformer giving out, it will have both primary and secondary cut-off without disturbing others in the same group.

Through an opening in the wall, under the floor, are led the cables, which run from the low tension bus bars into the main building, one group of heavy rubber covered cables going to each switchboard in the main room, the object being to sub-divide the power as much as possible, and thus reduce the chances of a short circuit, no set of cables carrying more than 1,200 horse-power. In each of these groups of cables are inserted circuit breakers, which may be tripped automatically or by hand, so that in the event of trouble on one group of panels that particular group, amounting to 1,200 horse-power, may be disconnected from the low tension bus bars in the transformer house.

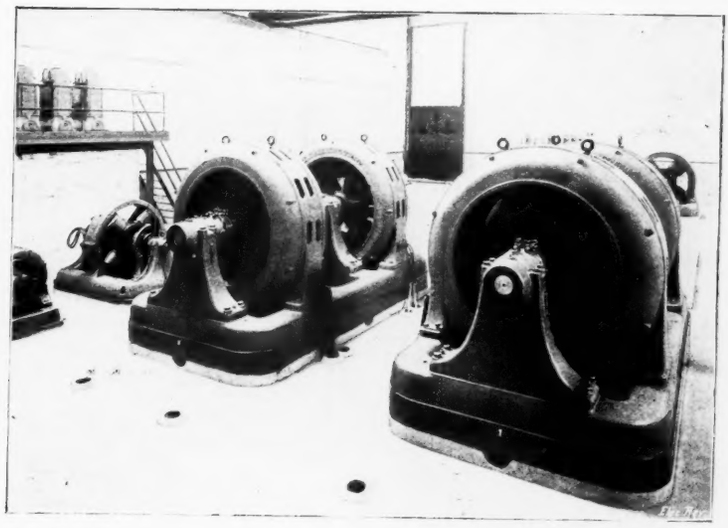
One of the substantial and serviceable novelties of the station is found in the subway that extends around three sides of the generator room. This subway is 6 feet high × 4 feet 6 inches wide. On the walls are placed iron shelves, $\frac{3}{16}$ inch thick × 10 inches wide, supported by angle irons built into the wall. From four to seven of these shelves are placed one above the other, thus forming a resting place for the numerous lead-covered cables running to motors, generators, street circuits, &c. Connecting these subways, and running at right angles to them, are rows of tile conduit, broken by manholes, from which rise tile connections to the various motors, rotaries, generators, &c., all wires being under the floor, and each circuit in an individual tile conduit. The iron shelves in the subway have breaks of 12 inches every 6 feet, and above these breaks a flue tile 8 × 14 inches rises 4 inches above the cement floor, and 4 feet 6 inches from the wall, affording means of connecting the cables in the subway to the various switchboards.

The northern half of the generator room will be entirely devoted to arc apparatus, and the southerly half to alternators, three-wire rotaries and 550-volt rotaries. On the north side of this room there is at present installed six 150-kw. 352-volt three-phase synchronous motors, each of which is direct connected to two No. 11 Brush, 125-light 9·6 ampere generators, these generators being fitted with the new oil-type automatic regulator, and a special iron-clad ammeter on the terminal board, making each machine entirely self-contained. The motor drives the arc machines by means of a very simple yet efficient form of insulating flexible coupling, consisting of four arms or spiders on the motor shaft and a similar number on the generator, each compressing rubber rolls 3½ inches in diameter × 4¾ inches long. This forms what has proved to be a most serviceable coupling.

All the switchboards in the generator room are of blue Vermont marble. Each panel is 30 × 100 × 2 inches, the motor board being at one end of the room, and the generator board at the opposite end, each standing out 4 feet 6 inches from the walls and directly in front of the tiles opening into the subways. The rows of conduits already mentioned run down every alternate aisle.

The synchronous motors are started through reacting coils fastened on slate bases, and to the walls directly behind the panels connected to them. Three single-pole double-throw switches, when down, turn current into the stationary armatures after passing through the reactances, and thus keeping down the starting current to 150 per cent. of full load current. The three-phase currents in the stationary armature induce secondary currents in the revolving field pole faces, and thus develop about one-quarter full load torque, which is sufficient to bring the motors up to full synchronous speed in about 70 seconds, when the 110-volt exciting current is thrown into the fields, and the proper adjustment made with the field rheostat for minimum current in the armature, after which the single-pole switches are thrown up, one at a time,

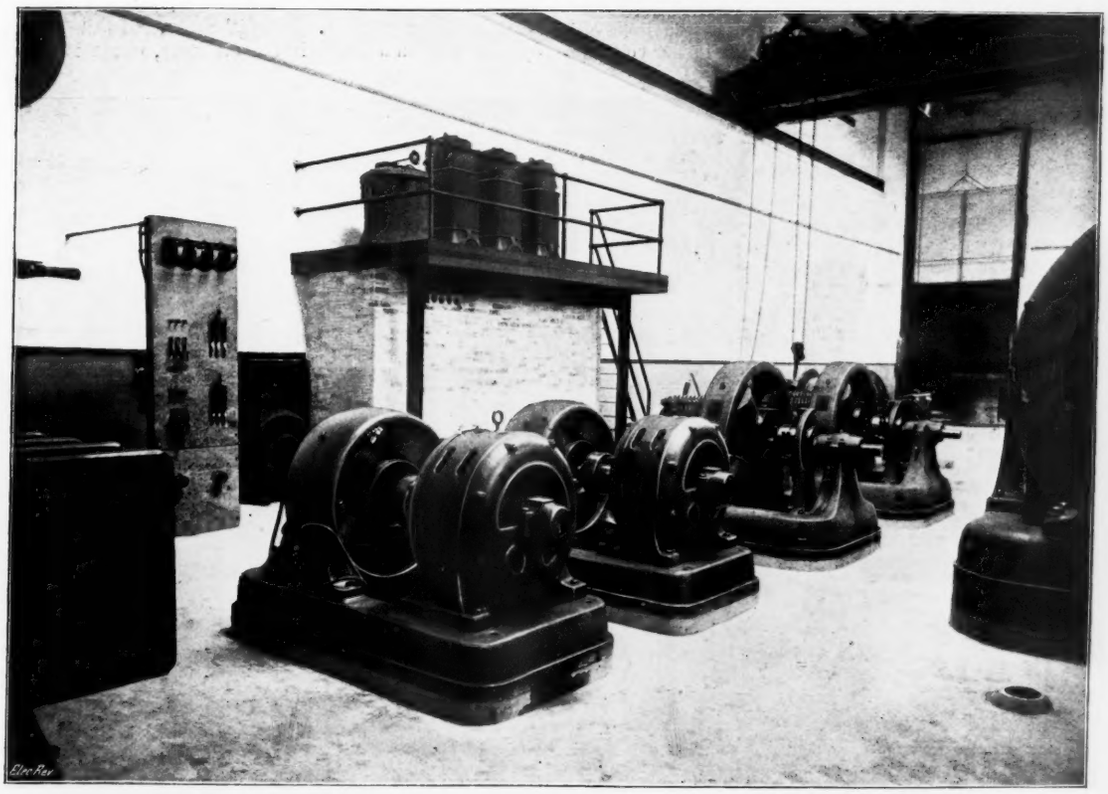
the motor meanwhile running single-phase, thus cutting out the reactances entirely. The full load efficiency of the motor is 94 per cent. In the construction of the plant foundations have been put down for 15 sets, each set having a capacity of 250 2,000-C.P. arc lamps, thus giving a total capacity of 3,750 arc lamps. In the meantime, however, developments on the long promised rectifier are being closely watched, and, if successful, will be used in place of more motor-generator sets, owing to the increased efficiency and decreased floor space it will give. To summarise results obtained in this station, it may be stated that the Buffalo General Electric Company get motors, generators, and switchboards in a space of $1\frac{1}{10}$ square foot per arc lamp.



425-kw. Synchronous Motor Direct-Coupled to 400-kw. Quarter-Phase 60-Cycle Generator.

In the southerly half of the generator room are two exciter sets, consisting of a 30-H.P. induction motor direct connected to a 20-kw. 125-volt generator, each of these exciter sets being capable of furnishing the entire exciting current to the synchronous motors. These motors are started through compensators fastened to the wall behind the switchboard controlling the exciter sets. Next to these are the two large motor-generator sets, consisting of a 425-kw. three-phase synchronous motor direct connected to a 400-kw. two-phase 60-cycle generator, both motor and generator being of the revolving field type, the latter giving off in two independent circuits having a phase relationship 90° apart 2,200-volt $62\frac{1}{2}$ cycle current. As the motors have eight poles and the generators 20, it is evident that in synchronising the two generators there are several possible phase relationships, all depending on which pole "locks" in the two motors. The phases in the quarter-phase generators may be 18° apart or any one of five or six possible combinations. To overcome this a synchronising voltmeter is connected between the two generators, and when one is running and the second one is being brought up to speed the field is thrown into the generator, and when the synchronising voltmeter shows zero the field of the motor is closed, thus locking the motor at the proper place.

The switchboard arrangements for these large motors are identical with those for the 150-kw. motors with the addition of one double-pole single-throw switch, which controls two of the primaries of the two to one ratio compensator, this being cut out entirely by throwing up the three single-pole double-throw switches.

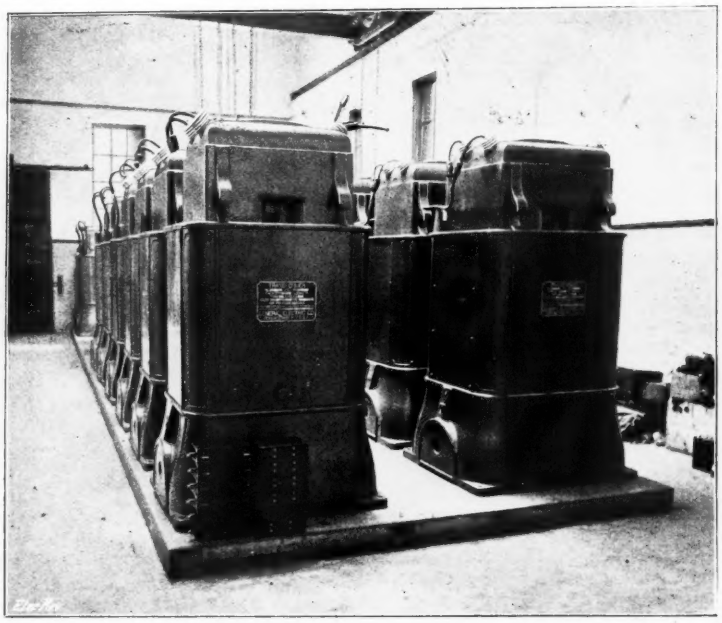


The Exciter Sets and 125-volt Rotaries with Transformers for 125-volt Rotaries on the Gallery.

The switchboard for the 60-cycle generators consists of

two generator panels, two feeder panels, and one total output panel with the necessary instruments. In the bus bars of each phase are connected two potential regulators of the C. R. type, giving a 4 per cent. boost or lower with one-fourth of 1 per cent. steps in order to balance up the phases if necessary. The efficiency of the 425-kw. motor is 96·5 per cent., and of the 400-kw. generator 96 per cent. with a regulation of 7 per cent.

Two 100-kw. 125-volt rotaries have been installed in order to make a start with the new three-wire Edison system, mainly as an experiment in order to determine whether the regulation will be good enough on the power circuits, and also for charging up a large battery of storage cells, which it is contemplated to instal in the near future. These rotaries have induction regulators in the primaries of the three static transformers, reducing from 352 volts, three-phase, to 30 volts, three-phase, thus enabling a boost, or lower, of 10 per cent. to be given. Reactances are also permanently connected in the leads of each rotary, thus permitting a large variation in the voltage of each rotary by varying the field excitation, and thus the phase relationship of current and E.M.F.



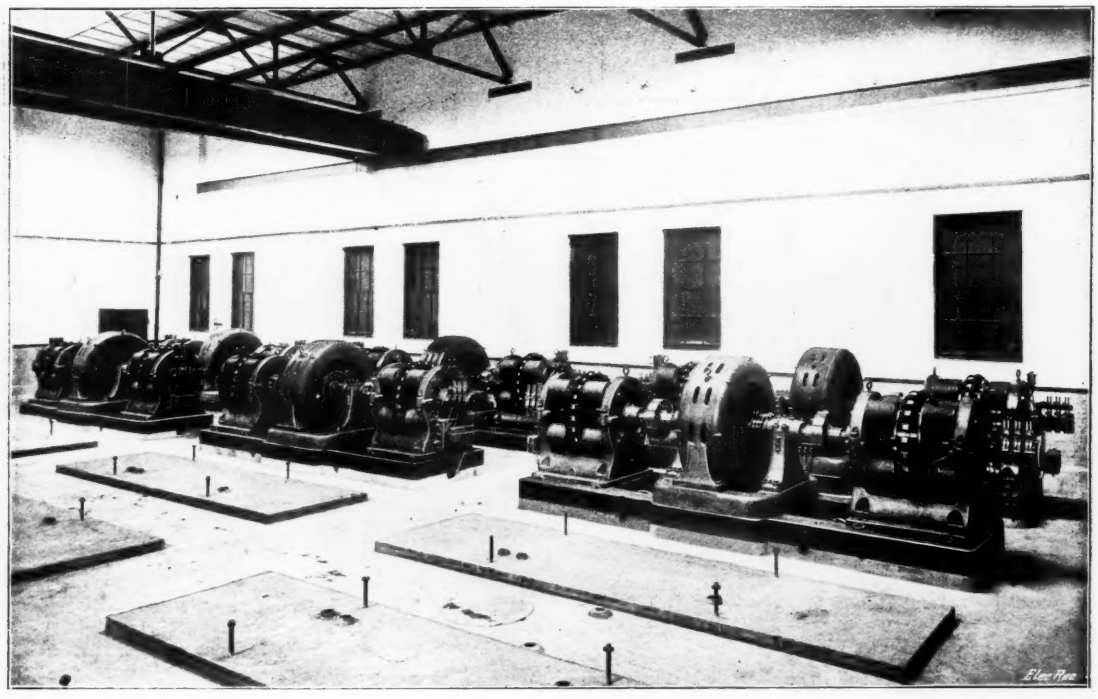
GENERAL VIEW OF THE 250-KW. TRANSFORMERS.

There are two 200-kw. 550-volt rotaries which supply power to a very healthy business in 550-volt motors running elevators, machine shops, &c. Provision has been made in this line for an increase of four times the present capacity, as this is believed to be the probable result, within a year or two, of the application of cheap Niagara power in Buffalo. These rotaries are started through reactances in exactly the same manner as the synchronous motors, a special switch being mounted on the frame, which opens the circuit between each of the field poles, thus breaking up the high potential induced from the armature in starting. The panels of the switchboards controlling these rotaries are similar in design, so far as possible, in order to simplify operation.

The wire tower is entirely fireproof in construction, and contains only lead-covered cables on insulators, separated 4 inches, and the lightning arresters mounted on an iron framework away from the cables.

At one side of the transformer room is the repair shop, which is about 25 feet × 26 feet in size. Opening off from it is the locker room for employés' clothes. In the rear and opening only on a court is the oil room, which is so constructed with fire walls that, in the event of fire, nothing would burn except the oil, the walls being of brick would simply form a chimney and prevent any possibility of the fire spreading.

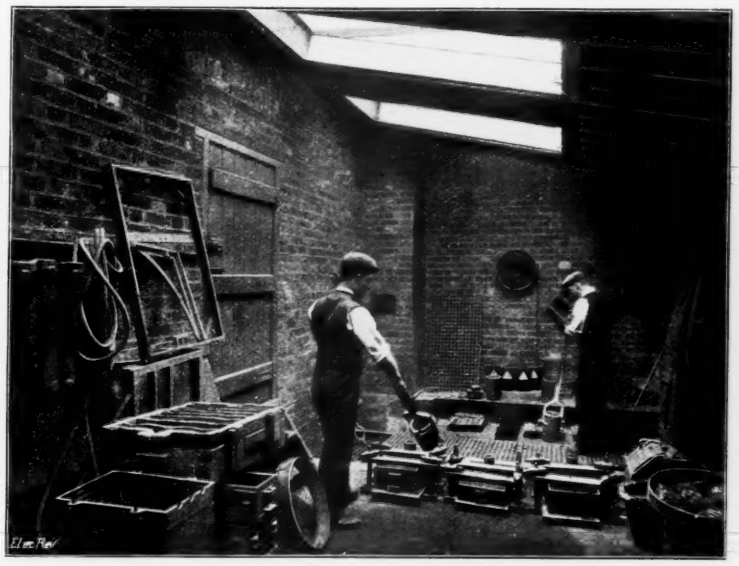
The transformers and switchboards in the transformer



VIEW OF 150-KW. SYNCHRONOUS MOTORS DIRECT-COUPLED TO BRUSH ARC MACHINES.

house are the property of the Cataract Power and Conduit Company, the distributing agents of Niagara power in Buffalo. This company has also a separate group of transformers, reducing the Niagara current to 2,200 volts, three-phase, for distributing to large power consumers, among whom will be the Urban Flour Mills, which will use about 500 H.P.

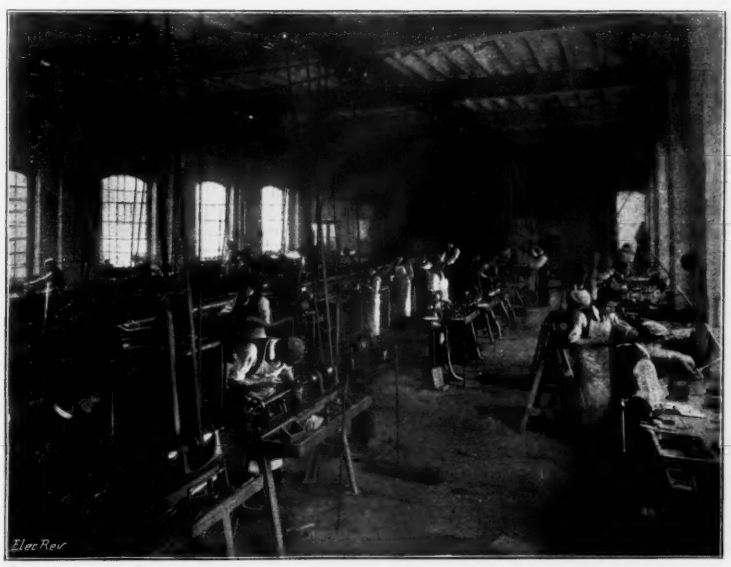
All the transformers, switchboards, motors, generators, &c., were furnished by the General Electric Company, of Schenectady. There is a total of 5,600 H.P. in transformers, 3,300 H.P. in motors and rotaries, and 2,160 H.P. in generators, together with the necessary switchboards and regulating apparatus, all forming a very handsome order of over 11,000 H.P. in complete equipment.



WILLIAMSON & JOSEPH'S NEW FACTORY.—VIEW OF FOUNDRY.

As stated, all the apparatus in the main building was erected and installed under the personal supervision of Mr. H. G. Stott, the engineer of the Buffalo General Electric Company, while the switchboard belonging to the Cataract Power and Conduit Company were erected and wired by Mr. I. R. Edmands, of the General Electric Company.

The Buffalo General Electric Company is the only company in Buffalo supplying electricity for lighting purposes, and the perfection which apparently has now been obtained in their facilities is the result of having men of force and financial strength at its head. The company was formed in the summer of 1893 by the consolidation of three companies, viz., the Brush Electric Light Company, the Thomson-Houston Electric Company, and the United States Electric Light Company. At that time the Brush Company was operating two plants, one on Elk Street for city lighting, and one on Wilkeson and Seventh Street for incandescent (alternating) and commercial arc lighting. The total output of this company at the time of the consolidation was about 1,000 H.P. The Thomson-Houston Company had one plant on Court Street, near Pearl, and had a total output of city and commercial lighting, including a small 500-volt power service, of about 600 H.P. The United States Company had a plant in the northern part of the City, in the Black Rock district, with a total output of about 300 H.P., chiefly city lighting. A year after the consolidation of these companies, the Elk Street and the Court Street stations were the only plants running in the city, the business having been consolidated into these two stations with the usual good effects following concentration, viz., reduction of operating expenses and increased efficiency.



WILLIAMSON & JOSEPH'S NEW FACTORY.—VIEW OF FITTING SHOP.

Within about a year of the consolidation the company suffered the complete loss by fire of all its electrical apparatus in both stations. However, the men interested were undaunted, and it is highly probable that the electrical fraternity will remember that the ashes of the fire were not cold before new machines were running in place of the old, the interruption, in either case, being not more than 36 hours. Special trains of apparatus were dispatched from all of the factories of the General Electric Company and Brush Company, then in Cleveland.

By the summer of 1895 the business of both city and commercial lighting had increased so steadily that numerous additions were made to both plants, including the taking out of small units and replacing with large. After numerous annexes had been built, or until there positively was no further room for expansion, the directors of the company had to face the problem of a new station on a new site, and with it the question of consolidating the two stations. This was in 1896. At this juncture still another problem presented itself for solution, and this was the power development of the Niagara Falls Power Company at Niagara Falls, and the probable effect, efficiency, and success of the transmission of this Niagara power to Buffalo. The question was, should the new station be operated by steam, or by electricity transmitted from the Falls? After mature deliberation, the latter form of energy was decided on as being best suited to all the requirements of the situation. The site selected for the new station was beside the old Wilkeson Street plant. This was owing to the fact that the company already owned this property, upon which stood old buildings. The lot has a frontage of 94 feet on Seventh Street and runs back to Staat Street 220 feet, so that, with the old buildings covering an area of over 9,000 square feet, there was no danger of being crowded out. Here, side by side, stand the

two stations, the one being the first alternating current station in the United States, the other the perfect modern development of a progressive company.

It may be added that the reason for the adoption of the 352 volts standard secondary pressure, at which current is received from the Cataract Power and Conduit Company, was that this pressure is suitable for use in 550-volt rotary converters without further transformation, and at the same time is a safe pressure and one easily handled with revolving field type motors in which all the small direct current is carried in the revolving part.

The wire tower of the old station was in use up to about six years ago. As compared with the new wire tower it is typical of the progress made in that period.

Williamson & Joseph's New Works.—Cabinet-making Shop.

MESSRS. WILLIAMSON & JOSEPH'S NEW WORKS.

Of the various branches of the electrical industry we suppose there is none more important than that which is devoted to the making of switches, switchboards, and all the paraphernalia necessary in the distribution of electricity. The switch gear is the one portion of an electric supply system on which one can nearly always depend in case of emergency. It is designed to regulate and occasionally check the vagaries of the more wayward portions of an electric lighting plant. There are fewer opportunities in switchboard work for brilliant achievements than, say, dynamo building, always excepting minimum cut-outs, which are probably most successful when they don't act. The switching arrangements of public supply works have undergone many modifications during the past few years. Ten years ago most engineers believed in small units and large switchboards, nowadays there is less desire for ornamentation and a greater craving for simplicity. It is not only in large central station work that switchboard manufacturers spend their energy, for perhaps the making of consumers' switching devices is more important from a trading point of view. If there are 1,000 electricity consumers in a town, and each consumer requires 10 switches—we do not propose to carry the calculation any further, but it will be obvious that there must be a very significant business done in that direction. Quite recently we have had an opportunity of inspecting a factory that may be said to be devoted exclusively to the manufacture of switchboards, switches, lampholders, fuseboards, &c., and on no occasion have we seen better exemplified the merits of organisation and good management. Messrs. Williamson and Joseph's new works at Canonbury, to which we are alluding, have been arranged not only with a view to facilitate the speedy output of apparatus, but the various operations dovetail together in a manner that suggests extreme economy in manufacture.

Williamson & Joseph's New Works.—Fitting Shop.

Some time ago the firm occupied considerable premises at Horsleydown, but the London County Council, in the exercise of its omnivorous desires for improvements, felt compelled to acquire the works. They did so, but it necessitated the services of an arbitrator to define the terms on which possession could be obtained, and eventually Messrs. Williamson & Joseph moved to the north side of the Thames.

The buildings at Canonbury have been laid out in a manner eminently suitable for manufacturing. The offices and showrooms are detached from the factory, though not sufficiently to prevent easy communication between them. Between the offices and the workshops is the foundry, where most of the brass founding necessary in the making of switches, &c., is carried on. On the ground floor are a number of machine tools that are mainly occupied in turning screws, shamfer heads, terminals, &c.: at the further end is the smithy, while the remainder of this floor is devoted to stores. The first floor is entirely utilised as a fitting shop, and one of the photographs will give an idea of the importance of this department. Above are the cabinet making and the lacquering rooms, an interesting view of the former being shown. The output of the cabinet-making department is considerable, and lies mainly in the supply of cases for fuseboards and the smaller type of switchboards, as well as frames for larger boards.

With the exception of polishing the marble and slate slabs, it may be said that a switchboard is made from beginning to end on the premises. After cutting down a slab to the desired size, the next operation would be drilling the requisite number of holes; for this purpose a somewhat novel form of drill is used, which is driven by a belt from one of the overhead shafts. The slab would then be ready for the fitter, who would fit on the necessary parts. While looking round the factory we noticed the construction of special battery switches, these are operated by means of two hand wheels, a smaller one rotating inside the circumference of the other, the larger one controlling the discharge, while the smaller one controls the charging and also moves back the discharge switch. There are some excellent types of milling machines employed in the shops, one being a profile machine, the depth of cut being controlled by one hand and the speed with the other. While some machines were employed in stamping out various sizes of metal pieces, others were engaged in cutting and shaping copper and brass. Prentice cut-outs, the English patents for which are owned by Messrs. Williamson & Joseph, were being made in considerable numbers, and some fairly large lighting switchboards were under process of construction. Although the greater proportion of the work being carried out was electrical, a good many speed indicators were being manufactured, the only portion of these not made on the premises being the dials.

Many of the various switches and cut-outs made by this firm have been already described in these columns. It is, however, a matter of considerable interest to know that organisation in manufacture and the selection of proper machine tools enables the firm to turn out small switches and lampholders that are cheap and, at the same time, well made. We believe Messrs. Williamson & Joseph were among the first makers of porcelain switches in this country, and though public taste now runs in the direction of metal switches, porcelain has not been altogether abandoned. Although the machine tools at present in use are of quite modern type, steps are being taken to introduce a number of lathes that will be entirely automatic in their action. These will be mainly devoted to screw making and kindred work. The factory is driven by gas engines of the Stockport type, and very shortly it will be lighted throughout by electricity.

ELECTRIC LIGHTING NOTES.

(*Continued from page* 87.)

Edmonton.—The District Council has asked the engineer to report as to "the practicability of utilising the two small engines for the production of electric light."

Shoreditch.—The Lighting Committee announced to the Vestry on Tuesday having considered a report from Mr. Newton Russell, chief engineer, upon the large demand for current during the past quarter and preceding periods of similar duration. The report showed that during the quarter ended September 29th, 1897, the number of units sold amounted to 57,452; in December, 1897, to 127,266 units; in March, 1898, to 196,214 units; in June to 182,584 units; in September to 203,892 units; and in December, 1898, to 313,558 units. The committee expressed the opinion that from these figures it would be seen that the capital expenditure for the new generating station now under consideration was fully justified. On the motion of Mr. H. E. Kershaw the report was received without any discussion. The committee further reported that new cables to the value of £2,750 were required for connecting the transformers now being ordered according to the list of tenders published in another part of this issue. On the recommendation of the committee the Vestry sanctioned the expenditure and the placing of the order with the British Insulated Wire Company at their original contract price. The committee announced that a sub-committee had been appointed for the purpose of considering and reporting upon sites suitable for the proposed new generating station. In this connection a letter was read from the Ironmongers' Company declining to dispose of the site of the almshouses in Kingsland Road for this purpose. The Vestry approved the action of the Lighting Committee in instructing Mr. Russell to select and appoint a shift electrician.

South Africa.—Electric lighting is making progress in the smaller towns of South Africa as well as in the larger ones. At Uitenhage the Town Council are taking steps towards its introduction. It is suggested that motive power may be derived from the water works. There is apparently a gravitation supply of water with a sufficient head to give sufficient power for a nucleus of the electric lighting scheme, if not to light the whole town. Sir J. Sivewright, the ex-Commissioner of Public Works to Cape Colony, has been requested to nominate an engineer to prepare plans and estimates.

Southwark.—Last week the Electric Lighting Committee reported to the St. George-the-Martyr Vestry that they had considered the two letters from the Board of Trade, enclosing copies of letters from the County of London and Brush Provincial Electric Lighting Company, Limited, asking permission to change the system of the supply of electrical energy. The company desired to change the system laid down to two-phase alternating currents, which request the committee did not, however, deem it advisable to accede to. As the Board of Trade desired an immediate reply, the vestry clerk wrote to the Board stating that this authority did not agree with the company's proposal, and this action was last week approved by the Vestry. The same committee also presented a report on "Generating Stations and Supply of Electrical Energy." They recommended that this Vestry support the views of the Hammersmith Vestry with regard to certain suggestions contained in the report of the Joint Committee of both Houses of Parliament.

St. Pancras.—The Electricity Committee reported to the Vestry on Wednesday that the prevailing wet weather was delaying the work of completing the extensions at the Regent's Park station. It was expected that the arc lighting of Prince of Wales Road and Malden Road would be completed by the contractors in seven weeks, and the extension of the mains by the Vestry in the Highgate district would be finished in about the same time.

Stirling.—The tenders for electrical plant are in the hands of Prof. Kennedy for adjudication.

Taunton.—The Council is joining with other authorities in resisting Mr. Martin Rucker's claims for infringement. The Electric Light Committee has reported that the undertaking is making progress, the increase of the output being about 50 per cent. on ordinary days, and 100 per cent. on Sundays.

Tonbridge.—A deputation from the Ratepayers' Association went over to Dover last week to inspect the electric lighting and tramway undertakings there. The same night the deputation reported to a meeting of the Association at Tonbridge. A provisional electric lighting order has been already obtained.

Towyn.—At a special meeting of the Towyn (Merioneth) Council, Colonel Ruck further explained the scheme for lighting Towyn and Aberdovey with electricity, and a committee has been appointed to consider the whole matter, and confer with other interested parties.

Uckfield.—Messrs. Verrall & Borlase have again written to the Council *re* application for a provisional electric lighting order. Referred to a committee.

Walton.—The District Council will not approve of the proposed Walton and Weybridge provisional order.

Weston-super-Mare.—The District Council notifies in the *London Gazette* that it intends to transfer its 1891 provisional order to the Weston-super-Mare and District Electric Supply Company, Limited.

Whitby.—Notification having been received that the Board of Trade will revoke the 1891 provisional order if no steps are taken to carry out the powers within 12 months, the District Council has appointed a committee to consider whether the order shall be sold to a company or carried out municipally.

Wigan.—The Electric Lighting Committee's deputation which has visited Leeds, Bradford and Wakefield, to inspect the electric lighting and tramway systems of those towns has issued a report upon what it saw.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Birmingham.—Judging from an article in the *Birmingham Argus* there is a growing feeling in favour of the municipalisation of the tramways. It seems that this would be the easiest way of putting an end to the discreditable tramway deadlock here.

Charing Cross and Hampstead Underground.—Power is sought by the Charing Cross, Euston, and Hampstead Railway Company to extend its authorised system to a point near the Highgate Road Station of the Midland Railway, and to purchase or take on lease a portion of the Baker Street and Waterloo Company's line, as may be agreed upon. New share capital sought to be raised is £360,000, with power to borrow on debentures a further £120,000.

Dudley.—The British Electric Traction Company are now making good progress with the reconstruction of the Dudley tramways.

Halifax.—A trial trip was made on 16th inst. on the electric tram extension to Salterhebble. The mayor, the chairman of the Tramways Committee (Alderman M. Booth), Mr. Spencer (tramway manager), Mr. Street (electrical engineer), and a number of aldermen and councillors were among the party. A 15 minutes' service is proposed. The Board of Trade inspection is to take place this week.

Hurstpierpoint (Sussex).—At a meeting of the Parish Council on Friday, a letter was read from a firm of engineers, stating that they would be willing to provide an electric tramway and electric lighting for Hurst and district, to meet the wants of the locality. The Council will not oppose them.

Liverpool.—On Monday the electric tramway system was further extended by the opening of Prince's Park route. About a dozen new American cars were put on the service.

London United Trams.—The London United Tramways Company have deposited a Bill under which the powers granted to the company last session to work its tramways in Surrey by mechanical power are sought to be extended over the whole of their existing or authorised system, including the tramways of the company in the County of London.

The success of the company's all-night service of cars between Hammersmith and Kew, and Uxbridge Road and Acton, seems to be exceeding the expectations of Mr. J. Clifton Robinson and his co-directors. In a recent interview with a West London press representative, Mr. Robinson said that hundreds of men are already employed preparing the route for electric traction, the scheme for which is quite matured. When electric traction is in full swing the company expects, of course, to run its all-night service at a much cheaper rate, as well as more frequently.

Manchester.—A Failsworth electrical engineer advises the City Council to avoid both the conduit and overhead wire methods within the city by using the overhead system for all routes outside the centre of the city, and having accumulator bogies coupled to the cars at the point where the overhead wire terminates for the service in the centre of the city. These bogies would automatically disconnect the overhead current, and themselves make connection with the tram motors.

Morecambe.—Some gentlemen are prospecting and surveying for a proposed new electric tramway between Morecambe and Blackpool. If the scheme goes forward, it will develop a portion of North Lancashire known as the Fylde, which has been a quiet agricultural nook for many years.

Moss Side.—The Manchester Carriage and Tramways Company has just completed the extension of tramlines in this district, all the rails being bonded for electric traction. A Local Government Board inspection will take place shortly.

Redditch.—The District Council has received a letter from the Light Railways Commissioners saying that they propose to submit an order to the Board of Trade authorising the construction of the Redditch and District Electric Traction Company's scheme, subject to the widening of certain streets.

Southampton.—At last week's Town Council meeting, the Tramways Committee reported that on September 23rd, they recommended the Council to adopt electric traction for the tramways, and the overhead trolley system in the borough. At a meeting of the Council held on October 13th the recommendations were unanimously adopted, but on October 26th, the Council resolved to incur no expense on electric traction in any form, until a complete scheme was submitted to them for approval. In accordance with the last resolution the committee had given the whole subject of electric traction their most careful and thorough consideration. They had, in considering the various systems of electric traction, had the great advantage of the experience which had been gained in other towns in the United Kingdom, and also upon the Continent, and, as the result of this experience, the committee had come to the conclusion that the overhead trolley system (which, as before noted, the Council decided to adopt) was the system best adapted for the Borough of Southampton. Having come to this conclusion, the committee were now in a position, after consultation with their engineers, to present a complete scheme for the equipment and working of the tramways in the borough by this system. In the first place it would be necessary in order to give a quick and satisfactory service, to double the existing line wherever possible. The proposed double lines were shown upon the plan which was presented to the Corporation by the committee in their report on October 13th. The reports of Messrs. Kincaid, Waller & Manville to the committee on the subject were presented, and the committee summarised their recommendations as follows:—"1. Electric traction by the overhead trolley system, as already adopted by the Council. 2. Double all lines where possible. 3. Punctual service of cars on each route at intervals of five minutes, and from the Junction to Floating Bridge at intervals of 2½ minutes. 4. Retention of outside seat cars throughout the system. 5. Provision of additional headway through the Bargate by lowering the roadway to give an effective height of 15 feet 6 inches. 6 Protecting trolley wire under the Bargate. 7. Provision and equipment of overhead wires and trolleys, and electric equipment throughout the entire system. 8. Provision of stock of 20 motor cars, with running sheds. 9. The estimated cost of the above, complete (exclusive of lowering road under Bargate) £63,297. Since the above report has been prepared, we have obtained an estimate from the borough engineer for lowering the road under the Bargate, and its approaches on either side, which amounts to £425, making the total estimate to £63,722. The Committee desire to emphasise the fact that included in the above estimate is the cost of providing an equipment of three additional miles of tramway line, and also six miles of new tram roadway, which, apart from tramway purposes, will be of material advantage for general vehicular traffic; and the committee suggest that, bearing this in mind, a conference should be held with the Works Committee. The committee propose (subject to the sanction of the Council) to forthwith advertise for tenders as soon as the necessary plans and specifications have been prepared for carrying out the works detailed in this report, and for the necessary rolling stock, and propose to commence at once the section from the Junction to Shirley, with the view of the same being opened for traffic at an early date. After a lengthy discussion the various recommendations were adopted.

Strand to Wood Green Railway.—The proposal of the Great Northern and Strand Railway Company is to construct an electrical railway in two tunnels from the Great Northern Company's Wood Green station *viâ* Islington to the same company's King's Cross station, and from thence, *viâ* Southampton Row and High Holborn, to a point in the Strand near the Law Courts. The share capital is fixed at £2,400,000, with power to raise £800,000 of debenture stock.

Turnstall.—The Urban Council has, after conferring with the representatives of the British Electric Traction Company, agreed to the extension of the time for opening the tramways for a further six months, on certain conditions.

Walsall.—The Town Council on Monday decided to oppose the Bill by which it is proposed to confer further powers upon the South Staffordshire Tramways Company, with respect to the leasing and working of tramways by the British Electric Traction Company.

Warwickshire.—The Nuneaton and Chilvers Coton District Council approves the proposed overhead wire electric tramways in North-East Warwickshire. Mr. Wiseman, of Birmingham, is engineer to the promoters. The scheme provides for communication with Nuneaton, Chilvers Coton, Attleborough, Stockingford, Ansley, Hartshill, and Whittleford; and the lines will pass through a district which abounds in coal, clay, stone, and manufactories.

Waterloo to Baker Street Electric Underground Railway.—The promoters of the electric railway undertaking from Waterloo to Baker Street have submitted plans to the Vestry of St. Martin's-in-the-Fields, which propose the construction of a subway for passengers from the north-east corner of Spring Gardens and Charing Cross to a point opposite the Grand Hotel, and thence to the south-east corner of Trafalgar Square, to communicate with a railway station to be constructed at Charing Cross. The Vestry have intimated their intention of lodging a petition against the Bill in order to secure a *locus standi*.

TELEGRAPH AND TELEPHONE NOTES.

Alternative Cable Routes.—A correspondent of the *Times* draws attention to the necessity for being able to send telegrams by alternative routes in time of interruptions from various causes. The writer says that recently he wanted to send to Cuba by an alternative route, but no tariff having been established, he was informed that the message could not be sent. He concludes by suggesting that "in view of the possible system of all-British cables round the world, when there will be alternative routes to all places with varying charges, this state of things should be remedied; if not, we shall find that in the case of interruption to the Mediterranean cables we shall not be able to telegraph to India or Egypt *viâ* the North Atlantic cables and the Pacific because no rates have been published."

Telegraph in Central Africa.—A daily press telegram from Brussels says that M. Mohun, who left Antwerp last August in charge of an expedition to connect Lake Tanganyika and Nyangwe by telegraph, has arrived at the former place with a full complement of men and stores. The telegraph line runs in a north-easterly direction.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Amazon Company's cable—		
Cable beyond Gurupa ...	June 11th, 1898 ...	...
Para-Maranham	Nov. 14th, 1898 ...	...
Landlines.		
Majunga-Tananarive ...	Jan. 14th, 1899 ...	...
Communication with Jacmel (Haiti)	Jan. 11th, 1899 ...	Jan. 16th, 1899.

The Telephone Purchase.—The Council of the London Chamber of Commerce has passed a resolution affirming that, instead of the present Post Office and company dual control of the telephone service, the Government should acquire the undertaking.

The Glasgow Chamber of Commerce is advising the Corporation that it is not expedient to put down a separate telephone system for Glasgow. The Chamber recommends Government purchase and control of the entire service.

Turkish Telegraphs.—British mercantile houses at Constantinople suffered considerable inconvenience on 4th inst. at the hands of the Turkish Telegraph Administration, who would not deliver telegrams because the addresses were not registered, and demanded a registration fee of 100 francs. Reuter's correspondent writes home in very strong terms about this sudden freak, which is said to be one of many recent obstacles placed in the way of foreign merchants.

CONTRACTS OPEN AND CLOSED.

OPEN.

Barrow-in-Furness.—January 20th. The Corporation is inviting tenders for the wiring of the free library, Cornwallis Street. Plan of building at the office of the Borough Electrical Engineer, Town Hall, and specification from the Town Clerk, Town Hall, on payment of £1 1s., returnable as usual.

Belfast.—February 2nd. Tenders are wanted for cast-iron pipes, frames, and covers, earthenware conduits, cables, and Lancashire boilers. See "Official Notices" January 13th.

Belgium.—January 25th. Tenders are being invited until the 25th inst. by the Compagnie Générale de Traction, of 6, Rue de Meridien, Brussels, for the supply of 10 tons of galvanised iron wire and 9,000 porcelain insulators. Tenders to be sent to above from whence particulars may be obtained for 1 franc.

Bradford.—February 1st. Tenders are wanted for an installation for electric lighting at the Hammerton Street destructor for the Corporation. Specification may be obtained at the Electricity Department, Town Hall, Bradford.

Buxton.—February 6th. The District Council wants tenders for feeders, mains, and arc light leads. See "Official Notices" this week for particulars.

Christiania.—February 26th. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Consul-General at Christiania, stating that tenders are invited by the Norwegian State Telegraph Administration for the delivery of about 140,400 porcelain telegraph and telephone insulators. Tenders must be received at Christiania by 12 o'clock noon on February 26th, 1899. A copy of the specification, conditions, &c., may be examined on personal application at the Commercial Department of the Foreign Office any day, between the hours of 11 a.m. and 5 p.m.

Ealing.—January 30th. Tenders are invited by the Council for two 500-H.P. steam alternators and one 150-H.P. steam dynamo alternator. See our "Official Notices" January 13th.

Glasgow.—January 21st. The Corporation invites tenders for generating plant at one or other of their new electricity works:—Two engines each of 200, and two of 400; three of 1,100, and two of 2,200 indicated horse-power, with dynamos and condensing plant. Specifications, forms of tenders, &c., from Mr. Chamen, city electrical engineer. See our "Official Notices" December 16th, 1898.

Govan.—January 23rd. The Commissioners want tenders for the supply of water-tube boilers, feed heater, engines, dynamos, equalising transformers, boosters and motor pump, cables, accumulators, arc lamps and standards. Specifications from Mr. W. Arnot, 57, West Regent Street, Glasgow. See our "Official Notices" January 6th.

Halifax.—January 24th. Tenders are wanted for the supply of one 600-kw. steam alternator for the Corporation. See our "Official Notices" January 13th.

Leeds.—The City Buildings Committee has resolved to invite tenders for illuminating the Town Hall clock by means of electricity.

London.—January 25th. The Metropolitan Asylums Board want tenders for switchboards, booster and connections, battery, mains, steam piping, also wiring and fittings for the electric lighting of the Northern Hospital, Winchmore Hill, N. See our "Official Notices" January 13th.

London.—January 31st. The L.C.C. is inviting tenders for four continuous current dynamos, one motor generator, two switchboards and switches, &c., for the proposed Victoria Embankment installation. See "Official Notices" December 30th, 1898.

Lowestoft.—February 6th. The Corporation wants tenders for the supply of boilers, steam dynamos and motor boosters, storage batteries, switchboard, travelling crane, mains, arc lamps and posts; and for the lighting of the station. Consulting engineer, Mr. W. C. C. Hawtayne. See our "Official Notices" January 6th.

Stirling.—January 30th. The Burgh Commissioners want tenders for electric light mains. See our "Official Notices" January 13th.

Sunderland.—January 27th. The Corporation wants tenders for roadwork, with stoneware casings, and supplying and laying electric light cables. See our "Official Notices" January 13th.

Whitechapel.—February 7th. The Board of Works wants tenders for cables, arc lamps, steam dynamo, batteries, boilers, and other machinery and apparatus for electricity works. See our "Official Notices" this week.

CLOSED.

London.—The St. Pancras Vestry has accepted the estimate of the Brockie-Pell Arc Lamp Company, Limited, for the supply of about 50 arc lamps at £8 15s. each for the lighting of Gower Street and other roads.

London.—The Shoreditch Vestry on Tuesday considered the following tenders for the supply of additional transformers, being for three of 66-kw., and three of 33-kw., together with switch gear:—

	Transformers.	66-kw. armature.	33-kw. armature.	Long-range switch.
Electric Construction Company	£4,497	£270	£185	£65
T. Parker & Co.	4,914	250	180	50
Brush Electrical Engineering Company	5,388	420	230	79
Mather & Platt (exclusive of switch gear, value £1,000) ..	3,870	270	185	—

On the advice of the chief engineer the Lighting Committee recommended, and the Vestry decided to accept the tender of the Electric Construction Company.

Morecambe.—At the meeting of the District Council on January 9th, contracts were let for electric plant to Messrs. Thomas Parker, Limited, for £1,955, and to Messrs. C. A. Parsons and Co., for £2,525.

FORTHCOMING EVENTS.

Friday, January 20th.—At 6.30 p.m. Institute of Marine Engineers. Tenth annual conversazione at the Town Hall, Stratford.

Tuesday, January 24th.—Northern Society of Electrical Engineers, Manchester. Paper by Mr. Parshall on "Electric Traction."

Wednesday, January 25th.—At 7.30 p.m. Institution of Electrical Engineers. Students' meeting. Discussion on "Systems of Electric Traction."

Thursday, January 26th.—At 8.0 p.m. The Institution of Electrical Engineers. "Rules for the Regulation of the Wiring of Premises for Connection to Public Supply Mains," by J. Pigg, associate; "The Regulation of Wiring Rules," by C. H. Wordingham, member; "The Institution Wiring Rules," by R. E. Crompton, past-president.

Friday, January 27th.—At 5 p.m. Physical Society. Agenda: "On the Equivalent Resistance and Inductance of a Wire to an Oscillatory Discharge," by Edwin H. Barton, D.Sc., F.R.S.E.; Exhibition of (*a*) A Dephlegmator, (*b*) A Temperature Tell-Tale, by R. Appleyard; "On the Volume Changes accompanying Solution," by T. H. Littlewood.

At 8 p.m.—Institution of Junior Engineers. Lecture on "Measurements of Elasticity," by Prof. J. A. Ewing, F.R.S.

Saturday, January 28th.—At 7 p.m. Institution of Junior Engineers. Annual dinner, Westminster Palace Hotel.

Institution of Electrical Engineers. Students visit to the works of the Electric Welding Company, Hindon Street, Pimlico, S.W., on Saturday January 28th. Students' Secretary, Mr. M. Solomon, 22, Linden Gardens, Bayswater, W. Party limited to 30. Meet at the Institution, 28, Victoria Street, at 10.15

NOTES.

The Institution of Electrical Engineers.—The following is the official list of premiums awarded and presented at the meeting of this Institution on Thursday, 12th inst., for papers read during the session 1897-98:—

The "Institution Premium" to Horace F. Parshall, M.I.E.E., for his paper on "Earth Returns for Electric Tramways."

The "Paris Electrical Exhibition Premium" to Robert Hammond, M.I.E.E., for his paper on "The Cost of Generation and Distribution of Electrical Energy."

The "Fahie Premium" was not awarded, because no telegraphic or telephonic papers had been read during the session.

"Extra Premium" to Leonard Andrews, M.I.E.E., for his paper on "The Prevention of Interruptions to Electricity Supply."

Premium for "Original Communications" to Mr. H. N. Allen for his paper on "Sparkless Reversal in Dynamos."

"Student's Premiums" were awarded to Mr. J. M. Donaldson for his paper "Notes on the Dover Electric Tramways;" Mr. Maurice Solomon for his paper on "Hertz Waves and Wireless Telegraphy;" and Mr. E. E. Tasker for his paper on "Alternate Current Motors."

Salomons Scholarships were awarded to Mr. Tom Rolls Renfree, King's College, London, and Mr. H. J. Tomlinson, University College, London.

The Krieger Electric Cab.—The *Daily News* refers to a Press inspection, on 12th inst., of a new electric cab at the premises of the Motor Car Company in Long Acre. Many statements were made to the reporters as to the remarkable performances, &c., of the newly introduced vehicle, and it was said that a company is being formed to manufacture the cabs in England.

The Electric Lighting of the City of London.—Those who have noted recently the frequent and prolonged interruptions in the street lighting of the City will find that the failures work out even worse than might have been supposed. In his recent report, an abstract of which appears in the *Times*, Mr. A. A. Voysey, the electrical engineer to the Corporation, gives some figures relating to the subject. The total number of arcs in the main streets is 493. The total number of lamp failures in the year had been 1,466. The average time of extinction per lamp was 236 minutes. Ninety-eight lamps were late in starting, the average time being seven minutes. A sum of £352 had been paid in penalties by the Electric Lighting Company for failures and lateness in starting. The arrangements for testing the supply of electricity to the public lamps had not yet been made. The company who were responsible for the provision of instruments at their own expense were now in communication with the Board of Trade as to their requirements, the instruments being subject to the Board's approval. There was no reason why the provision of the necessary instruments should be much longer delayed. It was an exceedingly important matter, because, without proper arrangements for testing the duration and value of the supply of electricity to the public lamps, the means of ascertaining how far the public lighting agreements were fulfilled were quite insufficient. The private electric supply amounted to an equivalent of nearly 300,000 lamps of 8-candle-power. Seventy-eight instruments had been submitted to the engineer for testing, the bulk being meters; of these 43 per cent. were correct and 57 per cent. were either too slow or too fast. The cause of the variations was in the generating machinery. The company continued to maintain the precautions to prevent accident or injury to the public by electric shock or gas explosion arising out of the electric lighting works in or under the streets.

Last week there was a brief discussion at the Court of Common Council on the resolutions passed at the wardmotes with reference to the question of competition in electric lighting. Mr. Brooke-Hitching objected to the resolutions being referred to the Streets Committee, which, he said, had too much to do. He announced his intention to move at an early date that all resolutions affecting the electric lighting of the City should be referred to a special committee. To us it would certainly seem that the present position of electric lighting matters in the City demands the attention of a special committee. The Court might do worse than appoint such a committee straight away. The Streets Committee has, we should imagine, plenty to do without also pretending to deal properly with the many points that must necessarily arise in connection with the widespread dissatisfaction recently expressed with the private supply of the City, and also in connection with the question of competition, of defective street lighting, of the telephone service, &c.

At the meeting of the Court of Common Council last week, a question was raised by Mr. A. C. Morton as to the advisability of charging the City of London Electric Lighting Company for the privilege of having their cables laid across the City bridges. It seems that free way leaves were granted under agreements of 21 years, but the *City Press* says that the Corporation has the power to terminate them upon giving three months' notice.

Barking Boiler Accident.—It has been suggested to us by an experienced practical steam engineer that some pressure gauges are jointed to the union coupling with lead washers. These will open out when the coupling nut is screwed up, and when pressure comes upon them they are liable to fold back and close the orifice to the gauge. There are other mishaps liable to occur to gauges, and the moral should be that every boiler should have two gauges, two safety valves, and two water gauges also. In such cases the chances against all being wrong at once and dangerously misleading would be very great.

Chatham Dockyard Electrical School.—A new electrical school is being constructed for the Lords of the Admiralty at Chatham Dockyard. There has already existed for some years an electrical school for the troops at St. Mary's Barracks (a branch of the Royal Engineers' School of Military Engineering), and now the Dockyard and the Chatham Naval Depôt will shortly be equally well provided for.

Behr's Lightning Railway.—Mr. F. Behr is still pushing on his monorail system, as he calls it. We prefer to call it a pentarail system. Mr. F. Behr has been expounding its merits before the Liverpool Chamber of Commerce to the extent of promising a reduction to 18 minutes for the Manchester and Liverpool journey. He estimates the line to cost in all only £1,400,000, and he estimates traffic to pay 10 per cent. on ordinary shares and 4 and 5 per cent. respectively on half a million each of debentures and preference shares. Minimum speeds of 90 miles per hour are airily flung about, and 150 miles an hour is to be easily secured, of course by electrical means. We think Mr. Behr is well advised to consider electricity as the best form of traction for any new tramway, but we observe that he says nothing about curves. Does Mr. Behr intend to have his line *absolutely straight*, or does he intend at every section to graduate the speed to the curvature, and the inclination of the cars and the rails at a proper angle from the vertical? Unless he can promise to fill one of these conditions, we fear he will still find himself face to face with passengers hanging like so many wet towels over their seats. It would be impossible to sit tight with high speeds and curves. He may fit his cars with lateral pressure guide wheels, but he cannot similarly control his passengers. There is a curve on the Midland Railway a little south of Bedford Station, which even at a moderate speed will throw a passenger off a seat end unless he is expecting the shock. Yet on a railway some attempt at superelevation of outer rail is usually made. How is Mr. Behr going to cope with the equivalent necessity at much higher speeds? We want a satisfactory answer to this hitherto blinked question.

The Daimler Motor Company.—The second annual meeting of the Daimler Motor Company was a stormy affair. With less than £2,500 in hand, there are orders to come forward for £50,000 of business. How can this be done with so little capital in hand? There seems to be a good deal of friction between the directors and some of the shareholders. The question naturally arises, what was paid for the Daimler patents; how much real capital is there in the company; what did the promoters make out of its flotation, and what has been spent upon improving and developing the patents? The directors themselves claim to have made but insignificant blunders, considering they had in hand a new industry, but the motor car industry has been put back years by undesirable promotion.

Tesla Polyphase Patents Declared Invalid in Germany.—The New York *Electrical Engineer* says that the Reichsgericht of Germany has confirmed the decision of the lower courts declaring the Tesla polyphase motor patents invalid. The court reviewing the case, holds that the patents are void owing to their not having been worked according to the requirements of the German patent law. The court goes on to say, however, that even if the patent had been sustained on that ground, it would have been, nevertheless, invalidated owing to the fact that the invention was not adequately described in the German patent specification, whereas the American patent specification is clear. It is understood that the Helios Company, of Cologne, who control the Tesla patents in Germany, will no longer contest the suits which it has brought against several parties in Germany.

What was the Cause?—On 13th inst., at Lambeth, an inquiry was opened into the circumstances attending the death of Samuel Pugh, 32, an engine driver on the City and South London Electric Railway, who was found dead on his engine on Tuesday morning. Dr. Edward Morris, Clapham Road, said that having regard to all the circumstances of the case, and every other theory and probable cause being negatived, he was of opinion that death was due to shock from an electric current. He added that Dr. Bell was with him when he made the autopsy. Dr. Bell coincided in his view. Mr. Macmillan, who represented the railway company, said he thought the doctors would take a different view of the case when they heard that what they thought had happened could not have happened. The inquiry was adjourned.

Marconi Telegraphy.—With reference to the employment of wireless telegraphy for communicating between lightships and the shore, the Wireless Telegraph Company have for some little time been in communication with the secretary of Trinity House, and on the 10th of last month permission was finally given to instal the instruments on either the East Goodwin, the Gulf Stream, or the South Sandhead light vessel, the land station to be at the South Foreland Lighthouse. As the Wireless Telegraph Company had satisfactorily tested the Marconi apparatus at sea up to a distance of 25 miles during the time of the Kingstown regatta last July, they chose the furthest off of these light-vessels, namely, the East Goodwin lightship, which is 12 miles distant from the South Foreland lighthouse. All the apparatus was brought on the lightship in an open boat, and rigged up in the course of an afternoon, and on Christmas Eve the lightship and lighthouse were placed in perfect telegraphic communication. Many messages passed between the members of the crew and their families on that day, and there has never been the slightest hitch from the starting of the installation until the present moment, every message sent, from either shore or ship, being perfectly received at the corresponding station. Although the weather has been most tempestuous since the instruments were installed, they have not been in the slightest degree affected, but the same cannot be said of Mr. Marconi's assistant on board, who suffered considerably from the effects of *mal-de-mer*. This, however, only brings out another point, namely, that since the assistant, Mr. Kemp, went on board he instructed one of the lightship crew, Mr. East, so that he was able to work the instruments and keep in communication with the land station, although previously Mr. East had no information either as regards the Morse code or telegraph instruments. Consequently, the company claim that the problem of practically and economically connecting lightships and other vessels with the shore has now been very satisfactorily solved.

The London Chamber of Commerce and Electrical Questions.—At a meeting of the Council of the London Chamber of Commerce last week, the principal subject discussed was the proposal of over 70 municipalities to embody in Bills and provisional orders to be introduced in the coming session of Parliament, powers to manufacture and deal in electrical fittings and goods. Several resolutions were submitted by the Chamber's Electrical Trade Section for confirmation by the Council, in which serious objection was taken to this new departure in municipal enterprise. A motion was carried to the effect that a letter should be addressed to the Board of Trade strongly objecting to the principle of competition in the form proposed by local authorities. Other resolutions were passed, urging that the scope and sphere of municipal enterprise in opposition to, and exclusion of, private enterprise, should be defined, and with this object referred to a joint committee of the two Houses of Parliament.

Lectures.—A series of lectures for artisans on various topics has been arranged at Aberdeen University. On 28th inst. the subject is to be "Electric Discharges in Air and in Vacuum," Dr. A. Ogg being the lecturer.

At a meeting of Glasgow Technical College Scientific Society on Saturday, Mr. William Arnot read a paper on "Systems of Distribution for Electric Traction."

On 10th inst. Major W. H. Edwards lectured at the Liverpool Junior Conservative Club on "Electricity as Applied to Tramway Traction."

At the Leamington Town Hall on 16th inst. Mr. Mellows, B.Sc., lectured on "The Electric Current and its Practical Applications."

The Northern Society of Electrical Engineers.—On Tuesday, 24th inst., at the Albion Hotel, Manchester, Mr. Horace F. Parshall, M.I.C.E., M.I.E.E., will read a paper on "Electric Traction" at a meeting of the members of this Society. In view of the controversy now taking place on the scheme of the Manchester Corporation for the working of the tramways, a large meeting is expected. Invitations to be present have been sent to representatives of the Manchester, Salford, and surrounding Corporations and District Councils. Mr. J. S. Raworth, the President of the Society, will preside.

Inventive Ingenuity Runs Riot.—In our last issue we printed a letter from a correspondent who has a very ambitious scheme in mind for a trans-oceanic wireless telegraph service. But this gentleman's fertile brain is not limited to any one particular branch of electrical science, as will be seen from the following letter, appearing in last Saturday's *Local Government Journal*. Truly, the name Smith promises to be written indelibly on the pages of electrical history! At all events, it is a name that will never be forgotten:—

ELECTRICAL TRAMWAY TRACTION.

Sir,—With reference to the very debatable question as to whether the overhead wire or underground conduit system is best, it may be of interest to you and your municipal councillor readers to know that I propose to bring out, during next summer, a new form of electrical tramway traction which will dispense entirely with the use of the overhead wire, or underground cable or conduit systems, as each tramcar will carry its own electrical generator, which would be very light in weight and economical in working. It will also cost considerably less than the present systems, and would be far less likely to break down. Particulars of the invention will be duly supplied to you, as the electric tramcar which I propose making has been put to a severe test and trial and duly perfected.

Thanking you for inserting the above for the benefit of your many readers,

I am, yours faithfully,

37, Daniel Street, Cardiff. GEO. H. SMITH.

We have not words wherewith to afford the writer the merited measure of congratulation upon the achievements of his inventive genius.

Appointments.—Mr. James Keith, B.Sc., has been appointed chief electrical engineer to Messrs. Tuck & Co., Limited, of Dublin.

On Wednesday, the 11th inst., a farewell dinner was given by the staff of the Dover Electricity Supply Company, Limited, at the Hotel Burlington, Dover, to Mr. A. A. Whitlock, resident engineer, who is leaving after five years' service to take up the post of chief engineer at the County of London and Brush Provincial Electric Lighting Company's Wandsworth station. Mr. Whitlock is succeeded at Dover by Mr. L. W. Woodman, who has for some time been acting as chief assistant. The company has presented Mr. Whitlock with a writing cabinet and spirit tantalus.

Mr. George G. Scurfield, of Sunderland, has been appointed assistant electrical engineer at Carlisle.

Personal.—Mr. J. H. Woodward, who has been associated with the electrical manufacturing firms in Wolverhampton for the past 13 years, and who lately resigned the position he held with Messrs. Thomas Parker, Limited, has arranged to join the staff of Mr. A. H. Preece, consulting-engineer, of 39, Victoria Street, Westminster. Mr. Woodward will also undertake consulting work on his own account.

We understand that Mr. G. R. Hulme, of the Blackpool electricity works, has been appointed secretary to the Blackheath and Greenwich Electric Lighting Company, Limited.

Gas v. Electricity.—A Harrow paper gives figures showing the relative cost of lighting the School Chapel by gas and by electricity. The average cost of lighting by gas in 1893, 1894, and 1895 was £20 1s. 8d.; the average cost of lighting by electricity, with additional lights under the organ loft in the south aisle, in 1897 and 1898, was £17 10s. Meter rent was included in each case. It may be mentioned that gas is 4s. 3d. per 1,000, and electricity 8d. per unit.

Appointments Vacant.—The Ashton-under-Lyne Electricity Committee want a second assistant engineer at £100 per annum. See our "Official Notices."

The Southport Corporation wants a mains superintendent at £130 per annum. See our "Official Notices" this week.

The Torquay Corporation want a mains electrician. See our "Official Notices" this week.

French Submarine Boats.—The French newspapers have this week been publishing lengthy articles regarding recent experiments with the new submarine boat, *Gustave Zédé*. One journal mentions that at the competition opened in 1896 for the best type of submarine vessel, a plan was submitted for an offensive submarine boat called the *Narval*, which is now being built at Cherbourg, while six other boats of the same type are to be laid down this year at Cherbourg, Brest, Lorient and Rochefort. "These boats will go by steam on the surface, and will only use electricity under water. Their range of action will be much wider, and they will be self-controlling. At present two submarine boats are being built at Cherbourg: the *Morse*, a defence boat, and the *Narval*, an offence boat. The cost of each is roundly estimated at 650,000 francs. It is not the fortieth part of the cost of building an ironclad."

Patents on Multiple Switchboards.—The *Electrical World*, New York, for December 24th calls attention to the expiration on the 17th inst. of the United States patent, No. 252,576, issued to Leroy B. Firman. The *Electrical World* remarks that the existence of this patent "has absolutely prevented any independent manufacturer from making or any independent operating company from using a multiple switchboard." The Firman device, we believe, was not patented in England, and the only description of it that we are aware of in technical literature here is in Mr. Kingsbury's paper, read before the Institution of Electrical Engineers, and published in our issue of February 8th, 1895, where will be found an illustration of the patent drawing. Mr. Kingsbury describes the Firman board as follows:—"The subscribers' numbers were inscribed on a signal board placed in a central position. These numbers could be obscured by shutters. When a subscriber was put through, the operator would instruct the attendant at the signal board to obstruct the number. On disconnecting, the reverse instructions would be given. Before connecting a line, the operator would look at the signal board to see if the subscriber required were disengaged. This method was crude, but none the less deserves commendation as an attempt to overcome the difficulties which were becoming apparent. It is a multiple board without a test system. I cannot claim it as a link in the chain, because, as a matter of fact, the solution of the problem had already been in the Patent Office for over a year. It is in the specification to which I have already called attention—Scribner's, November, 1879. Numerous connecting points, without some prompt and certain means of indicating whether the line were engaged or disengaged, would be a remedy worse than the disease. A triangular conversation would be likely to produce more bad blood than a triangular duel." Assuming this view to be correct, it would seem that the expiry of the Firman patent has not so much importance as has been suggested; but, as the "busy test" patents expire, some practical methods of operating a multiple board will be thrown open to independent companies.

The Cotsworth Arc Lamps.—A correspondent says he has received a copy of the prospectus, marked "for private circulation only," of the Cotsworth Arc Lamp and Electric Lighting Syndicate, Limited. The company has been formed, with a capital of £54,000, to acquire the patents of H. G. Cotsworth, relating to arc lamps, to manufacture the same, and to carry on the business of electrical engineers. For our opinion of this arc lamp, as then exhibited, see the Electrical Review for July 1st, 1898.

Lord Kelvin.—There is a recently taken portrait of Lord Kelvin in the *Syren* for January 11th, together with some notes on his Lordship's achievements in science. The *British Realm* for 15th inst. also publishes a photograph and some general notes on the life of this "Grand old man of Science," as the writer terms him.

The General Power Distributing Company's Bill.—Mr. T. Bayley, M.P. for the Chesterfield Division of Derbyshire, in an address to his constituents this week, spoke at length in favour of the above Bill, and advocated free trade in electric lighting.

Electrical Association of New South Wales.—The seventh annual meeting of the Electrical Association of New South Wales was held on November 11th, at 70, Pitt Street, Sydney, Mr. A. C. F. Webb, president, in the chair. The hon. secretary read a paper by Mr. E. Halcombe Hewlett on the electrical supply of Rockhampton, describing his difficulties in getting into working order very imperfect appliances. The Rockhampton electrical supply was, he said, the first established for the public supply of electricity under statutory powers and with underground mains in Australia. The undertaking, now in the sixth completed year, had made poor progress, but the prospects for the future were fair. A vote of thanks was passed to Mr. Hewlett, who was congratulated on having run the works so well under very adverse circumstances. The annual report showed that the work of the past year had been as successful as formerly. A visit to the Sydney Observatory took place on April 30th. Four new members and one student member had been admitted during the past session. Four members had resigned. The total membership was 63. The Council of the Association had continued to urge on the Ministry the necessity of bringing in a General Electric Lighting Bill as a Government measure, and had been informed that a Bill was in course of preparation, and would be presented to Parliament as speedily as possible. The report was adopted, and a vote of thanks was passed to Mr. E. Martyn for his successful efforts in settling the Association's debt on the late Engineering and Electrical Exhibition. The following gentlemen were elected office bearers for the ensuing year:—President, Mr. A. C. F. Webb; vice-presidents, Messrs. P. B. Elwell and E. Noyes; hon. treasurer, Mr. E. Martyn; hon. secretary, Mr. J. H. Brearley; committee, Messrs. J. R. Bainton, G. R. Hodson, O. W. Brain, H. H. Kingsbury, and G. Fisher.

Municipal Electricity.—Mr. Robert Hammond has been interviewed by the *Municipal Journal and London* in regard to the large electric power schemes. His views are stated in an article entitled "The Attack on Municipal Electricity."

Institution of Junior Engineers.—The 14th anniversary dinner will be held at the Westminster Palace Hotel on Saturday, 28th inst. President Sir Wm. H. White, K.C.B., F.R.S., will be in the chair, and among those expected to be present are Mr. W. H. Preece, C.B., Sir John Durston, Prof. Ayrton, and Mr. W. Worby Beaumont. On Friday, January 27th, Prof. J. A. Ewing will lecture on "Measurements of Elasticity."

Silver Medal.—Sir William Bailey has presented to the Technical Education Committee of the Oldham Corporation a silver Joule medal for the best pupil in electricity or engineering, the subject being optional.

New Secretary to the Post Office.—Mr. George H. Murray, C.B., Chairman of the Inland Revenue Office, has accepted the appointment of Secretary to the Post Office in place of Sir Spencer Walpole.

Lancashire Electric Power Company's Bill.—A memorial has been presented to the Examiners of both Houses of Parliament against the passing of this Bill through the Standing Order stage. The memorial bears the seals of the Corporation of Warrington, and the Urban District Councils of Ormskirk, Lathom and Burscough, Stretford and Dukinfield. It is alleged that the promoters have failed to comply with the Standing Orders.

The Progress of Electricity.—The above was the subject of a discussion at the monthly dinner of the London Chamber of Commerce at the Trocadero Restaurant on Tuesday. In the course of speeches by the chairman, Mr. T. F. Blackwell, Mr. Sydney Morse, Major-General Webber, and Mr. E. Garcke, such questions as the Pacific cable, the telephone service, progress of electric light and traction, and the evil effect of municipalisation, were referred to.

NEW COMPANIES REGISTERED.

Joseph Booth & Bros., Limited (60,215).—This company was registered on January 9th, with a capital of £75,000 in £100 shares, to acquire the business carried on by John W. Booth, Wm. Booth, Arthur Booth, and John A. Booth, at the Union Foundry and Iron Works, Rodley, near Leeds, and to carry on the business of engineers, crane manufacturers, machinists, manufacturers of hauling and winding machinery, brass, steel, and iron founders, electricians, and suppliers of electricity. The first subscribers (each with one share) are:—John W. Booth, engineer, and Mrs. Louise J. Booth, Oaklands, Calverley, near Leeds; William Booth, engineer, Arthur Booth, engineer, Mrs. Anne Booth, and Mrs. Mary J. Booth, all of Longfield, Rodley, near Leeds; John A. Booth, Greenfield House, Bramley, near Leeds, engineer. The number of the directors is not to be less than two nor more than five; the first are John W. Booth, William Booth, Arthur Booth, and John A. Booth (permanent directors); special qualification, £2,000; remuneration as the company may decide. Registered office, Union Foundry, Rodley, near Leeds.

Engineering and Electric Works Company, Limited (60,224).—This company was registered on January 9th, with a capital of £5,000 in £1 shares, to carry on the business of general engineering contractors, electricians, mechanical engineers, suppliers of electricity, and electrical apparatus manufacturers. The first subscribers are:—Herbert Hayward, 118, Asylum Road, Peckham, S.E., clerk, 1 share; Cannam Woodcock, gentleman, and Charles W. Woodcock, engineer, 78, Grove Park, Camberwell, S.E., 1 share each; Charles H. Elliot, Kirk Braddon, Croydon Road, Beckenham, electrical engineer, 5 shares; E. J. Tumber, 8, Clitheroe Road, Clapham, S.W., electrical engineer, 5 shares; J. William Field, 14, Verran Road, Balham, S.W., clerk, 1 share; C. E. W. Ogilvie, 9, Holmwood Road, Bromley, Kent, solicitor, 10 shares. Registered without articles of association.

Kalgoorlie Power Syndicate, Limited (60,231).—This company was registered on January 10th, with a capital of £10,000 in £1 shares, to promote or assist in the promotion of a company to provide and apply electrical power for mining and other purposes, and to enter into an agreement with Emerson Bainbridge, Samuel H. Cox, and Richard A. Varden. The first subscribers (each with one share) are:—M. E. Williams, Winchester House, E.C., solicitor; George Neville, Winchester House, E.C., solicitor; J. B. Sealy, Winchester House, E.C., gentleman; James Doyle, 257, Winchester House, E.C., gentleman; George Baker, 75, Jermyn Street, S.W.; Edward Pope, St. Stephen's Chambers, Telegraph Street, E.C.; and C. E. Mozley, 62c, Stamford Hill, N., gentleman. The first directors (to number not less than two nor more than seven) are to be nominated by the subscribers; qualification, £100; remuneration, £100 each per annum.

South Coast Mutoscope Company, Limited (60,274).—This company was registered on January 12th, with a capital of £75,000 in £1 shares, to acquire from the Mutograph and Biograph Syndicate, Limited, a license to use certain inventions for improvements in the reproduction of living objects in motion, to manufacture, sell, let on hire, and deal in mutoscopes, biographs, and mutographs, and to carry on business as electricians, electrical, mechanical, and general engineers, suppliers of electricity, manufacturers of photographic apparatus and appliances, &c. The first subscribers (each with one share) are:—William T. Smedley, Newhall Street, Birmingham, chartered accountant; Thomas F. Wilson, 129, St. Vincent Street, Glasgow, solicitor; Sidney I. Field, 59, Church Street, Lozells, Birmingham, secretary; Griffith Coit, 20, Grey Coat Gardens, S.W., secretary; Ernest Shouls, 42, Balfern Grove, Chiswick, clerk; Peter Burt, Hollybank, Bothwell, engineer; and Claude W. F. Pearce, 35, Oakhurst Grove, East Dulwich, S.E., clerk. The first directors (to the number of not less than two nor more than seven) are to be nominated by the subscribers; the Mutoscope and Biograph Syndicate, Limited, may appoint such proportion of the total number of directors as the number of shares held by them bears to the total number issued; remuneration as the company may decide.

CITY NOTES.

The Yorkshire House-to-House Electricity Company, Limited.

THE report of the directors to be presented to the ordinary general meeting of the company, to be held at the Great Northern Railway Station Hotel, Wellington Street, Leeds, on Tuesday, January 24th, 1899, at half-past three o'clock in the afternoon, states that the Leeds Corporation, in exercise of the powers conferred upon them by the company's provisional order, gave notice on August 4th last, requiring the company to sell its undertaking. As the result of negotiations, it was agreed that the sale should take effect, as regarded capital expenditure, on August 31st, 1898, and as regarded revenue account, on September 30th, 1898, and that agreement was approved at a meeting of the company, held on November 21st last. The company's capital expenditure to August 31st, 1898, after deducting depreciation, was found to amount to £217,420 10s. 4d., and the purchase price is therefore to be paid, in accordance with the provisions of the company's provisional order, by the issue of £217,420 of Leeds Corporation 5 per cent. stock, redeemable only by agreement between the Corporation and the holders of the stock for the time being. The amount of capital assets included in the accounts is merely the nominal value of the stock, the market value of which cannot at present be accurately estimated. The transfer of the undertaking was completed on December 15th last. The Corporation have retained the services of the whole of the company's staff. The shareholders will be invited, at the extraordinary general meeting to be held at the close of the ordinary general meeting, to pass a resolution for the liquidation of the company. At the meeting to be held at a later date, for the confirmation of that resolution, the directors propose to submit the name of Mr. Grosvenor Talbot, chairman of the company, as liquidator, and the names of the other members of the board as an advisory committee. It will further be proposed that Mr. John Gordon, who has acted as the company's auditor, be appointed to audit the liquidator's accounts. The supply of electricity by the company on its own account having, as already stated, ceased on September 30th last, the revenue account now submitted shows the result of only nine months' trading, and excludes the most profitable quarter of the year. The profit available for dividend, including £1,329 2s. 5d. brought from the last account, and after providing £2,612 6s. 8d. for depreciation, on the scale demanded by the Board of Trade auditor, is £10,740 5s. 10d., which the directors propose shall be appropriated as follows:—

To Payment of interim dividend at the rate of 5 per cent. per annum on the amount called and paid up on the ordinary shares of the company, for the half-year ending June 30th, 1898 ...	£3,671	6	5
„ Payment of a dividend on the amount called and paid up on the same shares, which, with the interim dividend previously paid, will equal a dividend at the rate of 6¾ per cent. per annum for the year ending December 31st, 1898	6,981	9	8
„ Balance to carry forward	87	9	9
	£10,740	5	10

The number of lamps connected to the company's mains increased during the nine months ended September 30th, 1898, from 49,150 to 65,328 (35-watt lamps). The directors desire to express their hearty appreciation of the work done by the staff during the existence of the company, more especially by Mr. Green, the secretary, and Mr. Harold Dickinson, the engineer, who have held their positions since the commencement, and whose ability and disinterested services have been of the greatest value in developing the undertaking. The directors would also recognise the conspicuous care and skill exercised by Mr. Robert Hammond, consulting engineer, in designing and superintending the construction of the works, as well as his valuable efforts in establishing the company, and obtaining the provisional order for supply of electricity in Leeds. The retiring directors, Mr. Grosvenor Talbot and Mr. Robert William Eddison, being eligible, offer themselves for re-election.

At the conclusion of the ordinary meeting, an extraordinary general meeting will be held for the purpose of considering, and if thought fit, passing the following resolution:—"That the company be wound up voluntarily."

London Electric Omnibus Company.

THE third annual general meeting of this company was held on Saturday at Winchester House, Major S. Flood Page presiding.

The CHAIRMAN, in moving the adoption of the report, said that when they met about a year ago, on a resolution which he himself moved, a committee was appointed to examine into the business and position of the company. That committee reported in favour of the directors seeing whether anything better could be done, and that recommendation was accepted by a full meeting of shareholders. The board had been endeavouring to ascertain exactly the whole of the conditions necessary for the working of electric traction, especially with reference to accumulators. They believed they had a good asset in the Sola accumulator, but, unfortunately, they could not take any steps to deal with it owing to claims which were made. The gentlemen whom the directors believed to be the owners of these accumulators were compelled to go to arbitration to have these claims settled. He had no official information, but had reason to believe that a decision had been given. He referred to the syndicate which had been established for manufacturing electrical omnibuses—the Electrical Street Car Manufacturing Company—as the Electric Omnibus Company could not make them. The syndicate went to allotment; it had got premises, and was carrying out a considerable amount of experimental work. It had been making not only omnibuses, but cars. The company had, however, run short of money, and he thought there was going to be an increase of capital. If that were done, the company would continue to try to solve the problem. The shareholders might think they had made no progress; they might even say that in one sense they had been going backwards. They had had three omnibuses running successfully in the streets of London for three or four hours consecutively, but they had not been able to run one for 24 or 26 passengers continuously in competition with the existing omnibus companies. These three omnibuses were sent down to Wolverhampton to be overhauled, and the directors had been advised that electrical engineering was not yet sufficiently advanced to justify the firm to whom they were sent becoming responsible for their proper

working, and they also recommended a much smaller type of omnibus. The board had reduced the expenditure to the very lowest limit. They had practically come to an end of their capital. It was for the shareholders to decide whether the company should or should not be wound up. The chairman proceeded to discuss the agreement with Mr. Ward, one of the vendors, and the engineer of the company, and strongly criticised the management of the company by Mr. Ward. He added that if the shareholders decided that the company should be wound up, he (the chairman) would himself propose that it should be under the supervision of the Court, and the shareholders would then know everything connected with the company.

Colonel TURNBULL seconded the motion.

Mr. WARD warmly defended his action, and challenged the most searching investigation into everything which he had done in connection with the company.

The report was adopted after considerable discussion, and on the invitation of the chairman, a formal vote was taken as to whether the company should be reconstructed, or should go into liquidation.

The shareholders, it appeared, were strongly in favour of reconstruction.

Potteries Electric Traction Company, Limited.

AN extraordinary general meeting was held on Monday at Donington House, Norfolk Street, Strand; Mr. Emile Garcke presided. A resolution for making certain specified alterations in Clauses 82, 101, and 106 of the articles of association was submitted to the meeting. The chairman read the articles, and afterwards stated that the proposed alterations were required by the Stock Exchange. It was necessary for them to carry out the alterations before they could make a formal application for a quotation of the shares. The company was registered some time ago, and the statutory meeting, which it was necessary to hold within four months of the date of registration, was held before the prospectus was issued; but he was glad to have that opportunity of treating the present as if it were the statutory meeting. The company was registered on June 28th, and the statutory meeting was called for October 27th, but was adjourned to November 3rd, when it was held. They then issued their prospectus, and the whole of the share capital had been subscribed for, namely, 20,000 preference shares and an equal number of ordinary shares, which were allotted. The 20,000 ordinary shares included 6,666 which were issued to the British Electric Traction Company as fully paid in part payment of the purchase price. The articles provided for seven directors; the names of six of them appeared on the prospectus, and Mr. C. S. Drummond had been appointed to the vacant seat. That gentleman had very large experience in connection with electrical tramways, particularly in America. Their undertaking practically consisted of three separate tramways—The North Staffordshire Tramways, which they had taken over; the tramways extensions which were authorised under a provisional order of August, 1896; and the lines authorised under the Light Railways Order, which was confirmed by the Board of Trade in December, 1897. The North Staffordshire Tramways had been undergoing conversion to electric tramways for some months, and they hoped that these lines would be opened for traffic in a few weeks—a measure which they believed would have a marked effect on the company's revenue. The tramways extensions—their second undertaking—had been under construction for some time, and the electrical equipment was also well in hand. They now hoped to make rapid progress in carrying out these extensions. The light railways were also now under construction, but they had ample time to finish this work. It was, however, very desirable to complete them as soon as possible, for until all the lines were finished and working by electricity they would not derive the full benefit from the system. The time allowed by the Board of Trade for carrying out the tramways extensions expired on the 7th prox., but they had applied to the Board of Trade for an extension of time, and this application would now be supported by the local authorities, from whom, at first, there was some opposition. He concluded by proposing the resolution.

Mr. J. S. RAWORTH seconded the motion, which was carried unanimously.

Eastern Telegraph Company.

THE report of the directors for the half-year ended September 30th last, presented to the ordinary general meeting held yesterday, states that the revenue for the period amounted to £444,012, from which is deducted £121,377 for the ordinary expenses, and £41,717 for expenditure relating to repairs and renewals of cables, &c., during the half-year. After providing £2,523 for depreciation of spare cable, £6,965 for income-tax, there remains a balance of £271,430, to which is added £3,568 brought from the preceding half-year, making a total available balance of £274,998. From this balance there has been paid interest on debentures and debenture stock, £29,855; dividend on preference shares, £10,148; dividend on preference stock, £14,548; and two interim dividends of 2s. 6d. per share each on the ordinary shares, £100,000, together absorbing £154,551. After carrying £10,000 to the reserve fund for maintenance ships, £5,000 to the reserve in connection with the removal of head offices, and £70,000 to the general reserve fund, there remains a balance of £35,447, which is carried forward. The revenue includes £23,902 dividends for the half-year upon the company's shares in other telegraph companies. The new issue of £500,000 3½ per cent. preference stock, referred to at the last general meeting, was more than fully subscribed for by the shareholders. One section of the cable for which this amount is principally required, has been laid from Porthcurnow to Gibraltar, and the expedition with the additional cables from Gibraltar to Malta and Alexandria left the Thames on 27th ult. The conversion of the ordinary shares into ordinary stock, authorised at the last general meeting, was effected on November 1st. Shareholders who have not yet exchanged their share certificates for the new stock certificates are requested to do so without delay. The stock exchange committee has granted official quotations for the new ordinary stock and for the additional issue of 3½ per cent. preference stock above referred to. The directors are arranging for the building of a new cable repairing steamer to replace the ss. *John Pender*, which has been recently sold.—An extraordinary meeting will follow the ordinary gathering, for the purpose of considering a resolution to the effect that article 29 of the company's articles of association be altered by striking out the amount of £10, and inserting in lieu thereof £1; and that the directors be authorised from time to time to create and issue debentures or debenture stock charged on the revenue and undertaking of the company to rank *pari passu* with the existing 4 per cent. debenture stock.

The half-yearly meeting was held yesterday at Winchester House, the Marquis of Tweeddale presiding. The report and accounts were adopted. Our report will appear next week.

British Electric Traction Company, Limited.—An issue of 20,000 6 per cent. cumulative preference shares of £10 each, at £12 per share, was offered for subscription during the past week. It is hardly necessary to say that this company is the premier organisation in this country engaged in carrying out electric traction schemes, and already controls many of the most important tramway systems in the country. It is stated that the company is already earning sufficient profits to ensure the regular payment of dividends on the preference shares; and, having regard to the sound business that is likely to be done, the present issue should prove a good investment.

City and South London Railway Company.—The accounts for the half-year ended December 31st show a balance, after providing for the debenture interest and the dividend on the preference shares, sufficient to allow the payment of a dividend on the ordinary stock at the rate of 2 per cent. per annum, carrying forward a balance of £1,419. The dividend for the corresponding period last year was at the rate of 1¾ per cent. per annum, the balance carried forward being £1,510.

The Electric Construction Company, Limited.—The transfer books for the ordinary shares will be closed from January 18th to January 31st, inclusive, for the payment of the second half of the dividend of 6 per cent. per annum, declared on July 21st last.

British Insulated Wire Company.—At a meeting of the company last week it was decided to pay the preference dividend for the half-year ending December 31st last, viz., 3s. per share, less income-tax, on shares numbered 1 to 20,000.

Hampstead Electric Supply Company.—The directors notify the payment of the dividend on the 5 per cent. cumulative preference shares for the period ended December 31st.

Hastings Electric Light Company.—At a meeting held at Hastings on 12th inst. a resolution was passed winding up the company voluntarily, and Mr. James Woodhams was appointed liquidator.

TRAFFIC RECEIPTS.

The Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending January 14th, 1899, were £113 15s. 6d.; aggregate to date, £280 5s.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending January 13th, 1899, were £2,556 11s. 5d.; corresponding period, 1898, £2,365 3s. 2d.; increase, £191 8s. 3d.

The City and South London Railway Company.—The receipts for the week ending January 15th, 1899, were £1,107; week ending January 16th, 1898, £1,085; increase, £22; total receipts for half-year, 1899, £3,286; corresponding period, 1898, £3,259; increase, £27. Miles open, 3½.

The Dover Corporation Electric Tramways.—The receipts for the week ending January 16th, 1899, were £151 7s. 7d.; week ending January 17th, 1898, £108 3s. 4d.; increase, £43 4s. 3d. Total receipts to date, 1899, £306 8s. 4d.; corresponding period, 1898, £225 15s. 2d.; increase, £80 13s. 2d. Miles of track open week ending January 16th, 1899, 3; week ending January 17th, 1898, 3. Car miles run week ending January 16th, 1899, 4,134; week ending January 17th, 1898, 2,613. Number of cars week ending January 16th, 1899, 11; week ending January 17th, 1898, 7.

The Dublin United Tramways Company.—The receipts for the week ending Friday, January 13th, 1899, were as follows:—D. U. T. Co., horse cars, £2,027 11s. 3d.; ditto, electric cars, £555 10s. 7d.; D. S. D. Co., electric cars, £605 10s. 8d.; total, £3,188 12s. 6d; corresponding week last year—D. U. T. Co., horse cars, £2,703 13s. 4d.; ditto, electric cars, £122 16s. 6d.; D. S. D. Co., electric cars, £422 7s. 5d.; total, £3,248 17s. 3d.; decrease, £60 4s. 9d; aggregate to date, £5,892 1s. 5d.; ditto last year, £6,093 1s. 11d.; decrease to date, £201 0s. 6d. Worked:—The mileage open is 16 miles electrically, 28 miles by horses, as against 11 miles electrically, and 31 miles by horses, for the corresponding period last year.

The Halifax Corporation Tramways. — The receipts for the week ending January 11th, 1899, were £238; total receipts to date, 1899, from June 29th 1898, £7,356. Car miles run, 3,968. Miles of track open, 3½. Number of cars, 10.

The Liverpool Overhead Railway Company.—The receipts for the week ending January 15th, 1899, amounted to £1,387: corresponding week last year, £1,361; decrease, £24.

The South Staffordshire Tramways Company.—The receipts for week ending January 13th, 1899, were £628 18s. 8d.; aggregate receipts for two weeks, £1,086 16s. 2d.; week ending January 14th, 1898, £609 15s. 10d.; aggregate receipts for two weeks, £1,151 1s. 3d.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1896.	1897.	1898.	Closing Quotation, Jan. 11th.	Closing Quotation, Jan. 18th.	Business done during week ended Jan. 18th, 1899. Highest.	Lowest.
124,400*l*	African Direct Telegraph, 4 % Debs.	100	...	...	...	100 —104	100 —104	...	...
25,000	Amazon Telegraph, shares	10	...	...	...	3 — 4	3 — 4	...	..
125,000	Do. do. 5 % Debs. Red.	100	...	...	...	91 — 94	91 — 94	...	..
905,560*l*	Anglo-American Telegraph	Stock	£2 13s	3 %	...	66 — 68	67 — 69	68⅜	67½
3,047,220*l*	Do. do. 6 % Pref.	Stock	£5 6s	6 %	...	117 —118	118½—119½	119½	117½
3,047,220*l*	Do. do. Deferred...	Stock	...	...	...	17 — 17½	16½— 17	17⅛	16 11/16
130,000	Brazilian Submarine Telegraph	10	7 %	7 %	...	15½— 15⅝	15½— 15⅝	15⅝	15½
75,000*l*	Do. do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	110 —114	110 —114	...	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	4 %	...	2⅜— 3¼	2⅜— 3¼	...	...
10,000,000$	Commercial Cable	$100	8 %	8 %	...	180 —190	180 —190	...	...
1,332,523*l*	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	103 —105	103 —105	...	...
224,850	Consolidated Telephone Construction and Manufacturing	10/-	2 %	...	...	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Telegraph	10	8 %	7 %	...	10 — 11	9½— 10½	10 1/16	...
6,000	Do. 10 % Pref.	10	10 %	10 %	...	17 — 18	17 — 18	18	..
12,931	Direct Spanish Telegraph	5	4 %	4 %	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	10 — 11	10 — 11	...	...
30,000*l*	Do. do. 4½ % Debs., Nos. 1 to 6,000 ...	50	4½ %	4½ %	...	104 —107%	104 —107%	...	...
60,710*l*	Direct United States Cable	20	2½ %	...	...	11¾— 12¼	11¾— 12¼	12¼	12 3/16
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	102 —106	102 —105	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	...	...	...	174 —179	174 —179 xd	178½	175
1,295,000	Do. 3½% Pref. Stock	100	...	...	...	104 —107	103 —106 xd	105¼	103¼
500,000	Do. Prov. Certs., all paid	...	...	...	...	54 — 57	103 —106	...	...
89,900	Do. 5 % Debs., repayable August, 1899 ...	100	5 %	5 %	...	101 —104	101 —104	...	...
1,432,268*l*	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	124 —128	124 —128	126⅜	126½
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	...	17½— 18	17½— 18 xd	17⅞	17 5/16
16,200*l*	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	5 %	...	99 —103	99 —103	...	...
64,400*l*	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	5 %	...	100 —103	100 —103	101¼	...
320,000*l*	Do. 4 % Deb. Stock	Stock	4 %	4 %	...	125 —129	125 —129	128	127½
35,100*l*	Eastern and South African Telegraph, 5 % Mort. Deb., 1900 red. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	...	...	99 —103	99 —103	...	...
46,500*l*	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	...	...	100 —103	100 —103	...	...
300,000*l*	Do. 4 % Mort. Debs., Nos. 1 to 3,000, red. 1909	100	4 %	...	...	104 —107	104 —107	...	...
200,000*l*	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	4 %	...	...	104 —107%	104 —107%	...	...
180,227	Globe Telegraph and Trust	10	4½ %	4½ %	...	12½— 12¾	12½— 12¾	12⅜	12½
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	16¾— 17¼	16¾— 17¼	16 13/16	...
150,000	Great Northern Telegraph, of Copenhagen...	10	10 %	10 %	...	28½— 29½	28½— 29½	28¾	28⅝
150,000*l*	Do. do. do. do. 5 % Debs. ...	100	5 %	5 %	...	101 —104	101 —104	...	...
97,800	Halifax & Bermuda Cable, 4½% 1st. Mt. Dbs., w'n. 1-1,200, rd.	100	...	...	...	100 —103	100 —103	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	...	56 —59	57 — 60	59	...
100,000*l*	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	6 %	...	109 —112	109 —112	...	...
484,597	National Telephone, 1 to 484,597	5	5½ %	6 %	...	5⅝— 5⅞	5¾— 6	5 13/16	5 11/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	13 — 15	14 — 16	15	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	13 — 15	13 — 15	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	...	5⅜— 5⅝	5½— 5¾	5⅝	...
1,329,471*l*	Do. 3½ % Deb. Stock Red.	Stock	3½ %	3½ %	...	99 —102	99 —102	100	99½
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	⅝— ¾	⅝— ¾	...	...
100,000*l*	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	4 %	...	104 —107	104 —107	...	...
11,839	Reuter's	8	5 %	5 %	...	6½— 7½	6½— 7½	7⅜	6⅜
3,381	Submarine Cables Trust	Cert.	...	...	...	134 —139	134 —139	...	...
58,000	United River Plate Telephone	5	5 %	6 %	...	4⅓— 5	4⅜— 5⅛	...	...
151,733*l*	Do. do. 5 % Debs.	Stock	...	...	...	102 —105	103 —106	105	104
200,000*l*	West African Telegraph, 5 % Debs.	100	5 %	5 %	...	100 —103	100 —103	101½	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	½— 1	½— 1	...	...
150,000	Do. do. 4% Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	102 —105	102 —105	103	...
64,269	Western and Brazilian Telegraph	15	2 %	3½%	...	12½— 12⅝	12½— 12⅝	...	...
33,129	Do. do. do. 5 % Pref. Ord.	7½	5 %	5 %	...	8 — 8½	8 — 8½	...	...
33,129	Do. do. do. Def. Ord.	7½	*nil*	½ %	...	4 — 4½	4 — 4½	...	...
389,521	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	105 —108	105 —108	105	...
88,321	West India and Panama Telegraph	10	1 %	⅜%	...	1⅝— 2	1⅝— 2	1⅞	1 13/16
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	6 %	...	10¼— 10¾	10¼— 10¾	10⅜	10¼
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	6 %	...	9 — 10	9 — 10	9¼	...
80,000*l*	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	...	104 —107	104 —107	...	...
158,100*l*	Western Union of U.S. Telegraph, 6 % Ster. Bonds ...	100	6 %	6 %	...	98 —103	98 —103	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electricity Supply	5	6 %	7 %	...	11½— 12⅝	11½— 12⅝	...	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	...	...
34,000	*Chelsea Electricity Supply, Ord., ...	5	5 %	6 %	...	9 — 10	8½— 9½	9¼	9
60,000	Do. do. do. % Deb. Stock Red....	Stock	4½ %	4½ %	...	113 —115	113 —115	...	...
50,000	City of London Electric Lighting rd. 40,001—90,000 ...	10	7 %	10 %	...	22 — 24	22 — 24	23 1/16	23⅛
10,000	Do. Ord. Nos. 90,001 to 100,000	10	...	...	...	21 — 23	21 — 23	...	...
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	...	15½— 16½	15½— 16½	...	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	...	125 —130	125 —130	...	...
30,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—30,000	10	*nil*	*nil*	...	12 — 13	12½— 13½	13 3/16	...
10,000	Do. do. do. Nos. 30,001 to 40,000 ...	10	...	...	...	11½— 12½	12 — 13	12¼	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	...	14½— 15½	14½— 15½	15½	14⅝
17,400	Edmundsons Elec. Corp., Ord. Shares 1—17,400	5	...	5 %	...	5 — 5½	5 — 5½	5½	...
15,661	House-to-House Electric Light Supply, Ord., 101 to 15,761	5	...	4 %	...	9 — 10	9 — 10	9⅜	...
12,000	Do. do. 7 % Cum. Pref. ...	5	7 %	7 %	...	9½— 10½	9½— 10½	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	3 — 3½	3 — 3½	3¼	...
48,050	Do. do. do. 6 % Pref.	5	...	...	...	6 — 6½	6½— 6¾	6¾	6½
100,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	102 —104	102 —104	...	...
62,500	Metropolitan Electric Supply, 101 to 62,500	10	5 %	6 %	...	18 — 19	18½— 19½	19¼	18 9/16
22,500	Do. Nos. 62,501 to 85,000, £4 paid ...	10	...	...	...	10½— 11½	11½— 12½	11¾	...
220,000*l*	Do. 4½ % First Mortgage Debenture Stock	...	4½ %	4½ %	...	115 —119	115 —119	...	...
6,452	Notting Hill Electric Lighting	10	4 %	6 %	...	17 — 18	17 — 18	...	...
31,980	St. James's and Pall Mall Electric Light, Ord.	5	10½ %	14½ %	...	17 — 18	17 — 18	17½	17⅜
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	...	9 — 10	9 — 10	9¼	9¼
65,000	South London Electricity Supply, Ord., £3 paid	5	...	...	...	3 — 3½	3 — 3¼	3¼	3
79,900	Westminster Electric Supply, Ord., 101 to 80,000 ...	5	9 %	12 %	...	15½— 16½	16 — 17	16⅝	15⅝

* Subject to Founder's Shares.

† Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid.

§ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME,	Stock or Share. ‡	Dividends for the last three years. 1896.	1897.	1898.	Closing Quotation Jan. 11th.	Closing Quotation Jan. 18th.	Business done during week ended Jan. 18th, 1899. Highest.	Lowest.
60,000	Aluminium "A" shares, Nos. 1—60,000	1	...	...	...	3¼— 3⅜	3¼— 3⅜	...	...
90,000	Do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	94 —100	94 —100	98¼	...
30,000	British Electric Traction	10	...	...	...	16 — 17	17 — 18	18	17
10,000	Do. do. 6 % Cum. Pref. 30,001—40,000 (issued at £2 10s. prem. all pd.)	10	...	...	...	13 — 13½	13 — 13½	13⅜	13 5/16
100,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	119 —121	119 —121	120½	119½
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	3	*nil*	*nil*	...	1⅜— 2	1⅜— 2	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	*nil*	4 %	...	2⅛— 2⅜	2⅛— 2⅜	...	...
125,000£	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	111 —115	111 —115	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red. ...	Stock	...	...	...	101 —104	101 —104	...	...
20,000	Callender's Cable Construction shares, Nos. 1—20,000 ...	5	...	...	...	9½— 10½	9½— 10½	10⅜	10¼
90,000	Do. do 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	110 —113	110 —113	...	...
35,250	Central London Railway, Ord. Shares	10	...	...	...	9⅜— 10¼	9⅜— 10½	10⅛	9⅞
178,303	Do. do. do. £8 paid	10	...	...	...	5¾— 6¼	7⅜— 8¼	...	...
61,033	Do. do. Pref. half-shares £3 paid ...	...	...	...	...	1½— 2	3½— 4	3⅜	...
71,447	Do. do. Def. do. £5 paid ...	...	...	...	...	4 — 4½	4 — 4½	4 5/16	...
630,000£	City and South London Railway	Stock	1 9/16 %	1⅞ %	2⅛ %	67 — 69	68 — 70	70	69½
22,500	Do. do. Ord. shares, Nos. 1 to 22,500 £4 pd.	10	...	...	...	3½— 4	3½— 4	...	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	...	...	2¼— 2⅜	2¼— 2⅜xd	2⅝	...
82,850	Do. 5% 1st Mort. Reg. Debs., 1 to 743 of £100, and 901 to 1,070 of £50 Red.	...	...	...	...	89 — 94	91 — 96	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	5⅛ %	6 %	...	2½— 3	2½— 3	2 5/16	2⅞
17,139	Do. do. do. "A" Shares, 01—017,139	5	5½ %	6 %	...	4 — 5	4 — 5	...	...
194,023	Do. do. do. 4 % Deb. Stock Red. ...	100	...	...	...	96 — 98	97 — 99	98	97½
112,100	Electric Construction, 1 to 112,100	2	5 %	6 %	6 %	2¼— 2½	2¼— 2½	2 7/16	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000 ...	2	7 %	7 %	7 %	2⅜— 3¼	3 — 3½	3 5/16	3¼
140,300	Do. do. 4% Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	105 —107	103 —105 xd	104⅞	...
91,196	Elmore's Patent Copper Depositing, 1 to 70,000	2	...	...	...	¼— ½	¼— ½	...	...
67,275	Elmore's Wire Manufacturing, 1 to 69,385, issued at 1 pm.	2	...	...	...	¼— ½	¼— ½	...	...
9,600£	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	7 %	...	10 — 12	10 — 12	...	...
12,500	Henley's (W. T.) Telegraph Works, Ord.	10	10 %	12 %	...	22½— 23½	23½— 24½	24⅜	23⅛
3,000	Do. do. do. 7 % Pref.	10	7 %	7 %	...	18 — 19	18 — 19	18½	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½ %	4½ %	...	110 —115	110 —115	113⅜	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	21½— 22½	21½— 22½	22⅝	22¼
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	102 —106	102 —106	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	2⅞ %	3½ %	3½ %	9 1/16— 10 1/16	10 — 10½	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	14¾— 15¼	14¾— 15¼	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	...	37 — 41	37 — 41	40½	39
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	...	...	...	...	...
13,400	Telegraph Manufacturing, Ord. Nos. 6,601 to 20,000 ...	5	...	...	...	7½— 8	8¾— 9¼	...	...
13,400	Do. do. 5% Cm. Prf. Nos. 6,601 to 20,000	5	...	...	...	5½— 6	5½— 6	...	...
540,000£	Waterloo and City Railway, Ord. Stock	100	...	...	...	111 —114	108 —111	110½	109

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 10⅛.
British Aluminium, Ordinary, 10—12; 7 % Pref., 11—13.
House-to-House, 4½% Debentures of £100, 103—106.
Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 13—14; 1st Preference Cumulative 6%, £5 (fully paid), 7⅜—8¼. Debentures, 103—106%. Dividend, 1897, on Ordinary Shares 10%.
National Electric Free Wiring, 10s. paid, 5/16 to 7/16.
Smithfield Market Electric, 4—5.
*T. Parker, £10 (fully paid), 15⅝—16⅛.

* From Birmingham Share List.

Bank rate of discount 4 per cent. (October 13th, 1898).

MARKET QUOTATIONS, Wednesday, January 18th.

CHEMICALS, &c.	This week.	Last week.	Increase or Decrease.
a Acid, Hydrochloric .. .. per cwt.	5/-	5/-	..
a „ Nitric .. .. .. per cwt.	22/-	22/-	..
a „ Oxalic .. .. .. per cwt.	32/-	32/-	..
a „ Sulphuric .. .. .. per cwt.	5/6	5/6	..
a Ammoniac, Sal .. .. .. per cwt.	37/-	37/-	..
a Ammonia, Muriate (grey) .. per ton	£19	£19	..
a „ „ (white) .. per ton	£26	£26	..
a Bleaching powder .. .. per ton	£5 15	£5 15	..
a Bisulphide of Carbon .. .. per ton	£15	£15	..
a Borax .. .. .. per ton	£16 10	£16 10	..
a Benzole (90 °/o) .. .. per gal.	7/-	7/-	..
a „ (50/90 °/o) .. .. per gal.	5/6	5/6	..
a Copper Sulphate .. .. .. per ton	£20 10	£20	10/- inc.
a Lead, Nitrate .. .. .. per ton	£23	£23	..
a „ White Sugar .. .. per ton	£30 10	£30 10	..
a „ Peroxide .. .. .. per ton	£27 10	£27 10	..
a Methylated Spirit .. .. per gal.	2/9	2/9	..
a Naphtha, Solvent (90 °/o at 160° C.) .. .. .. per gal.	5/6	5/6	..
a Potash, Bichromate, in casks.. per lb.	8½d.	8½d.	..
a „ Caustic (75/80 °/o) .. per ton	£24	£24	..
a „ Bisulphate .. .. per ton	£35	£35	..
a Shellac .. .. .. per cwt.	65/-	65/-	..
a Sulphate of Magnesia .. .. per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers .. per ton	£6 15	£6 15	..
a „ Recovered .. .. per ton	£5 15	£5 15	..
a „ Lump .. .. .. per ton	£5 5	£5 5	..
a Soda, Caustic (white 70 °/o) .. per ton	£7 10	£7 10	..
a „ Crystals .. .. .. per ton	£3	£3	..
a „ Bichromate, casks .. per lb.	3d.	3d.	..

METALS, &c.	This week.	Last week.	Increase or Decrease.
b Aluminium Wire, in ton lots .. per ton	£224	£224	..
b „ Sheet, in ton lots.. per ton	£191	£191	..
c Brass (rolled metal 2' to 12') basis per lb.	7¼d.	7d.	¼d. inc.
c „ Tube (brazed) .. .. per lb.	9¼d.	8¾d.	½d. inc.
c „ Wire, basis .. .. per lb.	7¾d.	7¼d.	½d. inc.
f Ebonite Rod .. .. .. per lb.	3/-	3/-	..
f „ Sheet .. .. .. per lb.	5/-	5/-	..
g Copper Bars .. .. .. per ton	£73	£70	£3 inc.
g „ Wire (basis price) .. per lb.	8¼d.	8¼d.	¼d. inc.
g „ Sheet .. .. .. per ton	£78	£70	£3 inc.
g „ Rod .. .. .. per ton	£73	£70	£3 inc.
n German Silver Wire .. .. per lb.	1/6	1/6	..
h Gutta-percha, fine .. .. per lb.	6/-	6/-	only 3 tons obtainable
h India-rubber, Para fine .. per lb.	3/11	4/-	1d. dec.
i Iron, Charcoal Sheets .. .. per ton	£18	£18	..
i „ Pig (Cleveland warrants) per ton	46/4½	45/1	1/3½ inc.
i „ Forgings, according to size per ton	From £11	From £11	..
i „ Scrap, heavy .. .. per ton	45/-	45/-	..
i „ Wire galvanised No. 8 .. per ton	£8 15	£8 15	..
g Lead, English Ingot .. .. per ton	£13 15	£13 15	..
g „ „ Sheet .. .. per ton	£14 10	£14 10	..
l Mica (uncut slabs 8" long) .. per lb.	6/6	6/6	..
m Manganin Wire No. 28.. .. per lb.	8/-	8/-	..
g Mercury .. .. per bottle	£8	£8	..
o Platinum .. .. per oz.	£3 1 6	£3 1 6	..
i Steel, Magnet, acc'd'g to desc'p'n p. ton	From £15	to £40	..
i Steel, Magnet, in bars	£58	£58	..
g Tin, block .. .. per ton	£102 10	£101	£1 10 inc.
g „ foil .. .. per lb.	1/4	1/4	..
n „ wire Nos. 1 to 16 .. .. per lb.	1/5	1/5	..
j Yarns, Cotton, Single 10lb. bundles pr lb.	6¾d.	6¾d.	..
j „ Flax, 6 or 8 lea... .. per lb.	4d.	3¾d.	¼d. inc.
j „ Hemp, 3 ply 10 lbs. .. per lb.	3½d.	3½d.	..
j „ „ Russian, 10 lbs. per lb.	4½d.	4½d.	..
j „ Jute, 180 lbs. rove .. per ton	£12	£12	..
j „ Manila, 24 thread .. per ton	£30	£29	£1 inc.
k Zinc, Sheet (Vielle Montagne bnd.) p. t.	£28	£28	..

a Quotations supplied by Messrs. G. Boor & Co.
b „ „ „ The British Aluminium Co., Ltd
c „ „ „ Messrs. Thos. Bolton & Sons.
d „ „ „
e „ „ „
f „ „ „ The India-Rubber, G.-P., and Teleg. Works Co Ltd
g „ „ „ Messrs. James & Shakspeare
h „ „ „ „ Jackson & Till

i Quotations supplied by Messrs. Bolling & Lowe.
j „ „ „ Henry C. Yeo & Co.
k „ „ „ Morris Ashby, Limited.
l „ „ „ Sanders, Wake & Co.
m „ „ „ W. T. Glover & Co., Ltd.
n „ „ „ P. Ormiston & Sons.
„ „ „ Johnson, Matthey & Co., Ltd

INSTITUTION OF ELECTRICAL ENGINEERS.

"Improvements in Magnetic Space Telegraphy." By Dr. Oliver Lodge, F.R.S., Member. (Paper read December 8th, 1898).

(*Continued from page* 68.)

Best Size and Shape of Coil for Violent Resonance.

It is of interest to find the shape of coil adapted to reduce damping due to ordinary resistance to a minimum. Let the coil be of mean radius a, of sectional radius c, and consist of n turns: then the volume of copper in it, ignoring insulation, is

$$\text{W} = \frac{\pi^2 c^2}{4 n} \times 2 \pi n a = \tfrac{1}{2} \pi^3 a c^2;$$

$$\text{L} = 4 \pi n^2 a \left(\log \frac{8 a}{c} - 1{\cdot}75 \right);$$

$$\text{R} = \frac{2 \pi n a}{\frac{\pi^2 c^2}{4 n} \kappa} = \frac{8 n^2 a}{\pi c^2 \kappa} = \frac{(2 \pi n a)^3}{\kappa \text{ W}}.$$

The damping time-constant, or reciprocal of the logarithmic decrement, is

$$\text{T} = \frac{\text{L}}{\text{R}} = \tfrac{1}{2} \pi^2 \kappa c^2 \left(\log \frac{16 \text{ W}}{\pi^3 c^3} - 1{\cdot}75 \right) = \frac{\kappa \text{ W}}{\pi a} \left(\log \frac{8 a}{c} - 1{\cdot}75 \right).$$

So T will be a maximum, and the damping a minimum, for

$$\frac{d \text{T}}{d c} = 2 c \left(\log \frac{16 \text{ W}}{\pi^3 c^3} - 1{\cdot}75 \right) - 3 c = 0;$$

or

$$\log \frac{8 a}{c} = 1{\cdot}75 + 1{\cdot}5 = 3{\cdot}25;$$

or

$$\frac{a}{c} = 3{\cdot}22;$$

which is, therefore, the condition for maximum T with a given W—*i.e.*, the condition for least damping, with a given bulk of copper.

This maximum $\text{T} = \text{T}_m = \frac{3}{4} \pi^2 \kappa c^2 = \frac{3 \kappa \text{ W}}{2 \pi a} = \frac{3 \kappa}{5{\cdot}5} \text{W}^{\frac{2}{3}}$

(= 3·4 seconds for a ton of copper).

The E.M.F. which the condenser will have to stand is $p \text{ T } \text{E}_0$.

The L appropriate to T_m is

$$\text{L}_m = 6 \pi n^2 a = 16{\cdot}5 \, n^2 \text{W}^{\frac{1}{3}}$$

(= 1,650 n^2 for a ton of copper).

The mean periphery of the coil is $5{\cdot}5 \text{ W}^{\frac{1}{3}}$

(or 5½ metres for a ton of copper).

The thickness of the coil, $2c = \frac{4 \text{ W}^{\frac{1}{3}}}{2{\cdot}345 \pi}$

(= 53 centimetres for a ton).

Such a thickness of coil may seem preposterous, but in certain confined spaces (*e.g.*, a lighthouse) it is advantageous so to be able to dispose the circuit, and the coil may consist of any amount of turns without detriment. What has to be scrupulously avoided in the neighbourhood of any coil is conducting material; but the reaction effect of such material falls off rapidly with distance—as the inverse 6th power (see Lodge, *Phil. Mag.*, Feb., 1880, p. 142)—and accordingly it is to be hoped that the general conductivity of the earth will not exert a very deleterious effect. Its effect will certainly be in the direction of increasing the resistance, and therefore the damping, of either coil; but, beside this reaction effect, a true partial screening of one coil from the other is to be found.

The thickness of wire is

$$c \sqrt{\frac{\pi}{n}} = \frac{\text{W}^{\frac{1}{3}}}{2{\cdot}07 \sqrt{n}} \quad \left(= \frac{50}{\sqrt{n}} \text{ for a ton of copper} \right).$$

Thus, for instance, the coil might have 10,000 turns of wire half a centimetre thick (No. 5½); the outside diameter of the coil would be 2½ metres, and the inside diameter 1½ metres. Such a coil would weigh a ton, and its resistance would be

$$\text{R} = \frac{48{,}000 \, n^2}{\text{W}^{\frac{1}{3}}} = 480 \, n^2 \text{ C.G.S.} = 48 \text{ ohms.}$$

Its self-induction would be 165 henries; its time of falling to $\frac{1}{e}$ the current, 3·4 seconds; and its magnification ratio, with a note of 400 per second, would be 8,500.

The condenser to be used with it for this note would be about $\frac{1}{1000}$ microfarad, or 9 metres electrostatic capacity. It might have an air or fluid dielectric to lessen hysteresis, and must be able to stand a very high potential—for instance, nearly a million volts if the applied dynamo E.M.F. is 100 volts.

The current in the wire would be only 2 amperes, and the energy expended therefore insignificant, viz., about 200 watts. In such a case the signalling would be done by the agency of the mass of copper rather than by mechanical power, and the tuning would be excessively sharp. There may be a few places where it is desirable to economise power to this extent, as, for instance, when the dynamo has to be driven by hand, or where space is very cramped, as in a lighthouse; but in most cases it would be far better to expend more power and open out the coil into a circuit enclosing a large area. This could nearly always be done at *one* of the stations.

A compact coil like this is not a powerful sender or receiver, in spite of its high magnification ratio. For instance, using a pair of such coils, one as sender and one as receiver,

$$\text{M} r^3 = (\pi n a^2)^2 = \tfrac{1}{4} \kappa \text{ R W } a^2 = \frac{10^{18}}{18} \text{ C.G.S.}$$

So the induced current, when properly attuned, is

$$\frac{p \text{ E M}}{\text{R}^2} = 2{,}500 \cdot \frac{100}{48} \cdot \frac{10^{18}}{18 r^3 \times 48 \times 10^9} = \frac{6{\cdot}4 \times 10^9}{r^3} \text{ C.G.S.}$$

So the distance at which this current would be a microampere (10^{-7} C.G.S.), or something quite audible, would be

$$r = \sqrt[3]{64 \times 10^{15}} = 4 \text{ kilometres only.}$$

Throttling.

The thickness of wire permissible without insulated sub-division into strands is regulated by the frequency. Taking Lord Rayleigh's value of the initial throttling, $p^2 \text{L}^2 \mu^2 / 12 \text{ R}^2$, it comes out $1{\cdot}2 \, n^2 a^4 \times 10^{-5}$ C.G.S. for copper; so, if the throttling is not to result in a greater increase of resistance than 1 per cent., a thickness of wire 1·08 cm., or No. 5/0, may be used for a frequency of 100 per second.

For 500 per second nothing thicker than 0·48 cm., or No. 6, should be used without sub-division.

For 1,000 per second No. 10, or 0·34 cm. thickness, is permissible.

For 1,600, No. 12; and for 2,500 per second the appropriate thickness is 0·216 cm., or No. 14 S.W.G.

If No. 2 wire, or 19/16, is used for 500 per second frequency, the loss due to throttling is 5 per cent.

If No. 0, or 19/12, is used, the loss is 9 per cent.

But if the strands are each cotton-covered before stranding, then there is practically no loss.

PART III.

Detectors.

A large number of devices for improving the detector of the fluctuating current at the receiving station were made and tried, and a few of them may be here described.

Tone Telephone.

Not only was it considered desirable that the two circuits should be attuned to each other and to the sending dynamo or intermitter, but also it was thought well to make the receiving telephone so that it would only or chiefly respond to one particular note.

I had found that the diaphragm of a Bell telephone need not be free everywhere, except at the edges, but might nearly as well be fixed all over to a thin deal sound board upon which the ear was directly pressed. Consequently I proposed to use this sound board idea for a tone telephone.

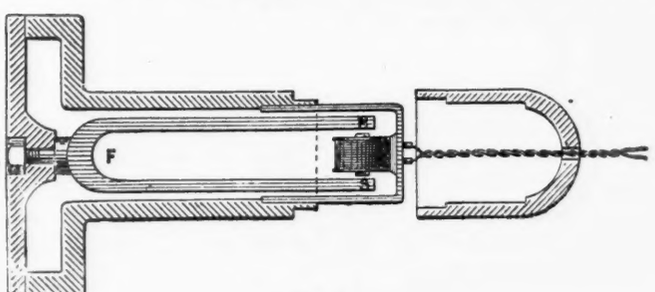


Fig. 1.

One good form is represented in figs. 1 and 2, where F is the tuning fork, screwed into a sound board, with its prongs highly magnetised, and with a short iron electro-magnet between its prongs, round which the received alternating currents were to circulate. The whole was mounted in a compact case, in general appearance like a Bell telephone, and the result was very sensitive to the proper note—distinctly more so than an ordinary telephone when both were in circuit. The ear was laid right upon the wooden end, Z, which holds the stem of the fork, and though, of course, the sound did not rise and decay quite sharply, yet signals could be clearly read, and the damping of the fork might be any time increased at the expense of a little sensitiveness whenever sharper—*i.e.*, quicker—signals were wanted. Such a tone telephone, arranged on a large sound board, or with a resonant jar (fig. 2), may serve as syntonic "call," accurately discriminating one station from another.

Another use for which it is convenient is to serve as a weak local sender for the purpose of detecting whether the receiving circuit is properly adjusted or not. Thus, for instance, suppose signals are expected from a distant station, and are not being received, it may be because the receiving circuit or its apparatus has gone out of tune a little; so its tone can be tested by twitching with the fingers the tuning fork of a tone telephone, whose local circuit is properly arranged in inductive connection with the main receiving circuit. It

gives at each twitch a feeble alternating current, which should make the receiving instruments decidedly respond. If they do not, they must be adjusted till they do.

Coherer.

Another totally different form of detector was suggested by the old experiment of the syntonic jars, where the air gap was filled by a pair of knobs in near contact, and with a local battery and bell—in other words, with what is now called a coherer circuit. So now

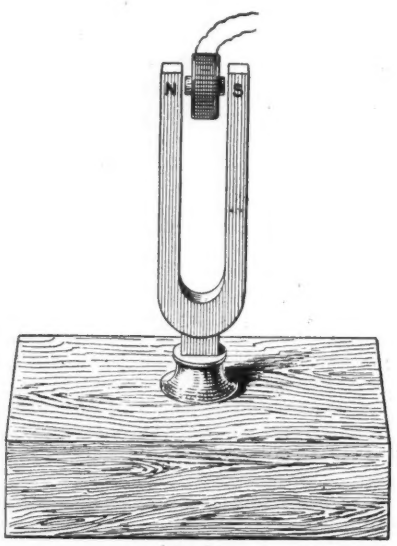


Fig. 2.

the receiving condenser can be shunted by a coherer, and a relay worked by the signals so obtained. But to the sinuous disturbance of an alternator a coherer turns out practically insensitive; it is to electric jerks that it responds. Accordingly, when the sender is of the make and break kind a coherer answers; but when it is of the slowly alternating kind it fails.

Coherer Call.

By inserting an interrupter in the receiving current so as to jerk any induced sinuous current that it may find there, the coherer can be made to work, and one plan of its connections is shown in fig. 3.

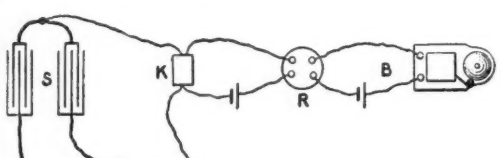


Fig. 3.

It may not at first be apparent why there should be two condensers in series in this figure, but it must be remembered that the interrupter must not be allowed to affect any portion of the local battery current, or, of course, the coherer will respond when no signals are being sent.

Bolometer.

A bolometric call was also tried, but, as it was not specially successful, the details of it will not be given.

Vibrating Coil Telephone.

For the purpose of disturbing a sound board, and in general of producing a mechanical effect in solids or liquids, as opposed to gases, it was thought probable that an iron diaphragm was not the best plan, but that the whole receiving coil might be mounted so as to be capable of vibration in a strong magnetic field.

An early form of the vibrating coil telephone and sound board is shown in fig. 4, where M is a large horse-shoe magnet with perforated pole pieces, one of which carries a sound board with a stretched wire from its middle passing right through the perforations to a screw-tightener, and carrying, rigidly attached to its middle, a light fine wire coil, matted together with shellac, and placed between the pole pieces.

The magnet was magnetised, not in the customary way, but with its adjacent poles of the same sign, so that the lines of force spread out through the coil, and give it the chance of cutting these rapidly if it moves at all axially.

On passing full alternating currents through the coil the sound board was strongly affected by its taut wire. A sub-divided iron core was also placed in the coil, but whether by reason of the

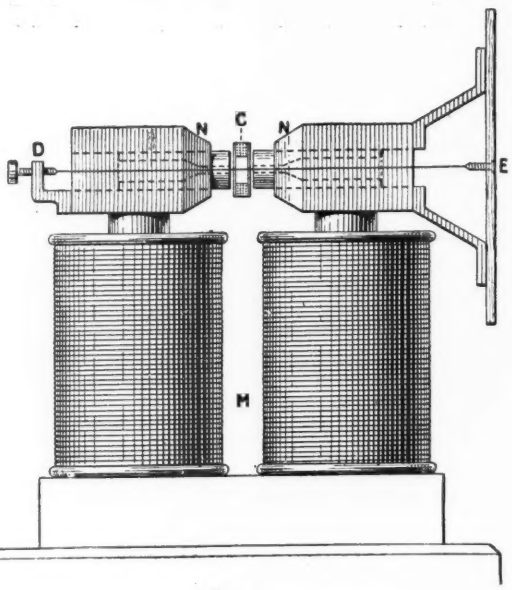


Fig. 4.

increased mass, or for some other reason, it did not now work so well.

Another form was then made, with a magnet specially designed as shown in fig. 5.

All the iron was well annealed, plenty of field winding put on, and the air gap was an annulus $\frac{3}{32}$ inch broad; no attempt was made to sub-divide the iron, because in this arrangement it is plain that

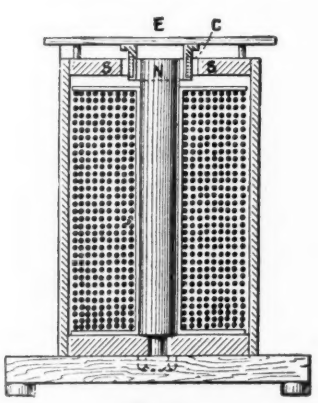


Fig. 5.

eddy currents are all to the good. They do not occur in any moving part, so the only effect is to diminish the impedance of the receiving coil. The coil is powerfully damped by the strong field, and a certain strength of field is therefore best.

The coil was attached direct to a wooden disc, and the thicker this disc the higher the note to which the arrangement most powerfully responded. By placing the ear on the wood, the first instrument on this plan was exactly as sensitive as the best of the used patterns of telephone—for instance, the Collier or the Ader pattern.

Tambourine membranes and many other plans were tried for holding the coil, but the simple wooden sound board answered best.

The wooden disc need not be clamped at its edge. It has a circular nodal line, and in three points on this coil it was sometimes clamped so that it could vibrate freely like a circular sort of harmonicon reed. Thus mounted it was very sonorous before the coil was put on. The load of the coil had to be taken into account in finding the nodes, and they were accordingly found experimentally. When the plate was unloaded its nodal line was 0·68 of its radius, which agrees with theory.

The loading, however, spoiled all this and greatly increased the damping, so that considered as a syntonic receiver it was not successful. The coils at this time were of copper, and heavy. Now they are of aluminium, and much lighter.

The present plan of a large sound board, and a light coil rigidly attached to its middle by either a light wooden tripod or a light cone, was then designed, and has not been improved upon.

Magnifying Telephone.

Instead of using the vibrating coil to affect a sound board direct, it was obvious that it might be used first to affect a microphonic contact of a local battery circuit, and thus cause a fluctuation in a stronger current than that induced from a distance, and so send on a more vigorous disturbance to another telephone, and thus cause a louder noise. For this purpose, after several microphonic transmitters had been tried, a Berliner was ultimately chosen, and arranged as in fig. 6.

Here the ordinary telephones are arranged so that the disturbance can be heard direct without magnification and compared with the magnified disturbance.

The telephone, T_1, serves for both determinations according to the key which is pushed down.

The telephone, T_2, was a duplicate of the same make, which was instated into either circuit when T_1 was out of it, so as to keep every-

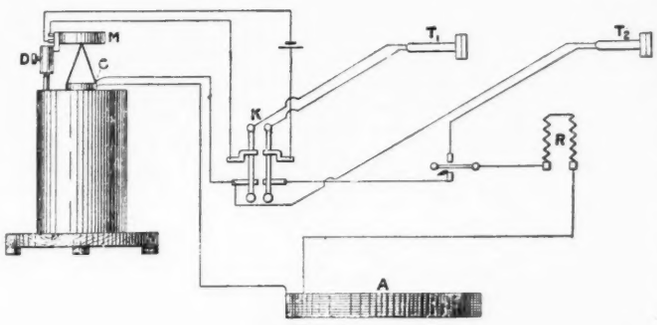


FIG. 6.

thing similar. It was found during the experiments that T_2 was unimportant; the resistance and inductance of the rest of the circuit were great in comparison.

At this early stage, and with the Berliner transmitter, it was found that magnification was easy when the original effect was fairly large, but that when the original effect was barely audible magnification became difficult, and never very marked.

(To be continued.)

THE BARKING EXPLOSION.

IT is suggested by the *Engineer*, with some show of reason, that the instances of very disastrous boiler explosions are those in which the shell has first given way in the steam space. The sudden release of pressure would cause the body of hot water to be suddenly lifted with considerable force, and the water would shatter the plates, thoroughly open the boiler, and let loose all the stored energy, amounting, in the present case, to about 288,000 foot tons.

It is said that the boiler was 20 years old, and this seems to have been considered as a telling point against the owners. We should say that we hold no such views, and consider Messrs. Hewett perfectly justified in using a boiler of this age, even if it had been removed from a ship as unfit for 90 lbs. It was only worked at 60, and might have been good for 20 years at that pressure. The pressure gauge appears to have moved back and forwards through what seems a very limited range, as the boiler got cool and hot, and the working on the safety valve does not appear to have been anything out of the way, though in getting up steam, a practical man should, with a newly started boiler, have tried other test openings, with a view to note the steam pressure by observation of its issuing strength. This may have been done. The boiler was re-tubed in 1897, and this would have afforded an opportunity of examining the condition of the plates internally. We think far less ourselves of the steam test to 90 lbs. than we do of the 200 lbs. hydraulic test. A suggestion has been made that some explosive may have got into the furnace. Now, an explosive acts by sudden expansion. It does not create a great pressure over a large volume of space. Loose in a furnace it might blow out the furnace doors; if it ruptured the furnace, it is doubtful if the effect would extend to the shell, unless the explosive was in some quantity. Nothing up to date has shown any reason to suspect a cause of greater moment than the excessive hydraulic test we named last week.

As regards the question of an explosion having occurred in the furnace, a witness at the inquest referred to two holes driven outwards into the water space. These do at least deserve consideration in the interests of the owners. There appears, so far, no evidence whatever that anyone had ever had any reason to express any doubt upon the soundness or safety of the boiler. Such information is very often forthcoming at inquests on boiler explosion fatalities; there is none in this case. The boiler had plates of $\frac{7}{8}$ inch thickness, though only 10 feet 8 inches diameter.

At the adjourned inquest evidence was given by Mr. Stromeyer, of the Manchester Steam Users Association, that the pressure at the time of the explosion was probably 400 lbs., or even more, but he could state nothing as to the manner in which this enormous pressure had accumulated. The pressure gauge was probably wrong. Thus, at present, the whole affair is somewhat mysterious, but it must be satisfactory to Messrs. Hewett to have it stated that their boiler was really in excellent condition.

TECHNICAL EDUCATION.

WHILE so much is talked of technical education, it is clear there can be no fixed policy. Mason College, Birmingham, is not flourishing, apparently not being of the sort to attract Birmingham. A London daily thinks it affords too literary a curriculum for such a business centre, and it is to be feared that the idea of many people of the education of a man in commerce is that there should be neither Greek nor Latin, and, in fact, nothing which is not of obvious and direct utility. This is a crude and coarse conception of education of any kind. Young men brought up on such lines are unbearable. We doubt if the people who advance such ideas really understand what they would invoke, nor is it probable that they only surround themselves at home with the strictly utilitarian, confining their furniture, for example, to the prophet's bed, chair, table, and candlestick, which appeared to be the Scriptural limitation of personal comfort. But we would rather see such bodily limitations than see the same economy applied to mental furniture. Probably the very failure of Mason's may be indicative of its need, of the lack of appreciation among Birmingham people of anything beyond the merely sordid.

But even Mr. Chamberlain demands attention for the higher general culture.

The University of Leipzig recognises commerce in an official kind of manner, and the Birmingham Chamber of Commerce would like to see the same at their own new university. But what is a commercial education? Is it to include merely the teaching of book-keeping and foreign languages? This will not teach commerce. Commerce cannot be taught. Languages should be; so should accounting, and especially should a sound geographical knowledge be taught. We don't mean that kind of geography which is little better than a record of a few bays, mountains, and seas, and the names of the towns on certain rivers. What needs to be taught to the extent of being appreciated is the reason why the big rivers run past the large towns. Why such a big town as Liverpool is so badly placed on a dangerous estuary. Why cotton can be spun so well in Lancashire. Why English railways which run N.W. and S.E. are easier made to pay than other lines.

Much of the success of the Germans has grown out of a methodical system of education of many years' growth. A child is taken and trained continuously in a given direction, but the Germans do not, we believe, try to make generals of all their boys, they limit their teaching to their capacities. Germans are taught well up to a point, and the machine runs well as a machine, but German training is rather apt to make a man a very efficient wheel or a good bearing, and he works as such. Englishmen may be less finished as to details, but in an emergency the machine resolves itself into a series of disconnected parts, each endowed with some automaticity. The German army would not be caught in so many traps as our own, but it is doubtful, should they be, whether they would respond and individualise as our men did at, say, Inkerman. Earl Spencer, speaking at the Association of Technical Institutes, thought we were behind America. We doubt it. American competition is purely the result of better specialisation. German competition is largely a matter of cheapness, but a recent visitor to Germany informs us he saw very little of striking moment in German ironworks; nothing equal to English practice. Our own opinion of English technical institutes is that they are practically wasted. They should be daylight schools, not evening sleeping places for work-tired lads.

See the number of them from the latest beautifully equipped Northampton Institute, and note the little good they are, the paucity of their staffs in numbers, and the short daily period of utility. These institutes ought to be available for the daily tuition of children of people of moderate means. They should directly follow upon the better grade primary schools, and in this way they might be productive of real good. They cannot now be of much use. Thousands of youths would attend day classes whose parents cannot pay the fees of such places as King's, and who find the evening classes impossible, involving late trains home, and, in the

case of boys at work, over exertion and injury to health. One year of thorough hard work at a good technical institution, where a boy would acquire a start in chemistry and physics, &c., would put a capable youth in a position to pursue his studies at home after going to the workshop, and he could, if disposed, learn more at home than at the institute, because he need waste no time waiting. It seems to us that a technical institute would be invaluable to such a boy if he could use it in an evening when he desired to have assistance on difficult points.

Probably, in course of time, some more satisfactory use will be made of our many technical schools. We must first rid ourselves of the idea of evening classes. A daily course as long as can be afforded, and opportunities for occasional evening assistance from, say, 5 p.m., or even a system of correspondence tuition, would do much. In the meantime, the machinery is there and the raw material to work upon as soon as we grasp the subject boldly. At the present we are all simply frittering away good opportunities.

THE ELECTRO-CHEMICAL AND ELECTRO-METALLURGICAL INDUSTRIES IN 1898.

By JOHN B. C. KERSHAW, F.I.C.

(*Concluded from page* 43.)

IV.—Copper.

The leading feature of 1898 in the refined copper industry has been the depletion of stocks owing to increased consumption, and the advance of prices from £48 to £56 per ton for G.M.Bs. Any estimate of the aggregate output of electrolytic copper in Europe is rendered difficult by the refusal of some of the refiners to furnish details of their production. The writer, from the answers that have been returned to him, estimates that it has varied between 25,000 and 30,000 tons for some years, and that no increase will have occurred during 1898. The output for the American refineries in 1896, as given by Titus Ulke, was 124,000 tons. There is reason to believe that both in 1897 and 1898 the increase in American production has been maintained. The total output of electrolytic copper by the refineries of America and Europe at the present date, is therefore probably about 3,400 tons per week, or 170,000 tons per annum.

During the year 1898 the difficulty experienced by English refiners in obtaining adequate supplies of suitable raw material has continued to check the expansion of the electrolytic refining industry in this country.

Recently, however, changes have been agreed upon by English firms as regards charges for smelting, which may lead to an increase of the shipments of unsmelted ores, and the development of copper mines which is occurring outside the United States, may also lead to an improvement of the position occupied by the English refiners with reference to supplies of crude copper.

The writer believes that there are at the present date 31 electrolytic copper refineries in operation distributed as follows:—America, 9; Germany, 7; France, 6*; England, 5; Russia, 3; Japan, 1; while there are, in addition, five copper depositing works where the Elmore and Dumoulin processes are in operation. During 1898 three of the older companies have been enlarging their plants, and new works have been erected at three localities in America. In 1899 electrolytic copper will therefore be produced in 39 works in Europe and America.

V.—Chlorates of Potassium and Sodium.

The four industries that have been hitherto noticed, are all represented in this country; and in one of these industries, the electrolytic alkali manufacture, the works in the United Kingdom are larger than those found in any other country. The manufacture of chlorates by means of electrolysis has not yet been introduced into this country. Although, a few years ago, the chlorate supply of the world was practically entirely drawn from English chemical works, the situation is rapidly changing; and two-thirds of the chlorate production of the world is now manufactured in electrolytic works situated in France, Germany, Sweden, and America. Two causes that have contributed to bring about this change have been the absence of any large water-power capable of easy and cheap development in the United Kingdom, and the fear that with steam power, the electrolytic manufacture of chlorates might not prove remunerative. The first cause will shortly be removed by the efforts of the financiers and engineers who have combined forces in order to create and utilise 30,000 to 40,000 H.P. at the head of Loch Leven in Scotland; and the correctness of the latter will be put to the test, by the experience of the Wenlock Electrolytic Company, capital £120,000; a company registered during the past year for purchase of a colliery at Little Wenlock, in Shropshire, and the manufacture of chlorate of soda and other chemicals by electrolytic methods. The number of works abroad engaged in this manufacture is now seven, situated at St. Michel,* Chedde, Valorbes, Bitterfeld, Leopoldschall, Mansboe, and Niagara.

The aggregate horse-power available for the manufacture is about 30,000, and the present output of these seven works is estimated by the writer to be about 6,500 tons. When one recollects that eight years ago this manufacture was in its infancy, the progress is striking.

VI.—Hypochlorites for Bleaching and Disinfecting Purposes.

The manufacture of solutions containing hypochlorite of sodium or of magnesium, and their use for bleaching purposes, is slowing extending, and a fairly large number of paper pulp mills and of textile bleaching works in France and Germany now possess their own electrolytic plant for the preparation of these solutions. As regards the cellulose factories the Kellner apparatus and process is most generally employed, though at Lancy, in Isére, the Corbin process is in use; while for bleaching textile goods the Vogelsang form of apparatus is used by the majority of bleachers. These installations are to be found chiefly in Germany and France, and the writer does not know of any paper mill or textile factory in England that has yet adopted these new methods of bleaching.

The essentially conservative character of the British manufacturer renders him over cautious, but in the course of the present year it is probable that trials of one of these processes will take place in English works.

There are no further developments to report in connection with the Hermite sewage disinfection process, and the unfavourable issue of the experimental trials at Bombay† seems to have effectually checked further work in this direction. The possibilities of the Septic-tank treatment of sewage is, doubtless, partly responsible for the cessation of all interest in the electrolytic method of treatment. If sewage can be adequately purified, by simply leaving it to the bacteria which multiply in enormous numbers in it under favouring conditions, it is obvious that all other methods of treatment must retire from the contest.

VII.—Ozone.

There is little progress of industrial importance to report in 1898 in connection with the production or utilisation of ozone.

Experimental work is being carried on in many quarters; but the writer is not aware that any of the proposed applications of ozone, with the exception of Otto's method of manufacturing vanillin, are yet working upon an assured commercial or industrial basis. The experimental work at Oudshoorn, in Holland, at Blankenberg, in Belgium, and at Paris, with the Tindall-Schnelle ozone process has been continued during 1898, but no reliable figures of cost based on these trials have yet come under the writer's observation. The experimental work carried out by Rosenblum and others in London with reference to the use of ozone for oil refining has resulted successfully; but the flotation of the Ozone Oil Refineries and Industries, a company which was organised to work this process, has been delayed, and the writer is informed by Mr. Yarnold that it will not occur for some little time.

* For description of this works, see Electrical Review, November 25th, 1898.

† Electrical Review, Vol. xli., p. 435.

VIII.—Zinc.

The chief event of 1898 in the electrolytic zinc industry has been the definite abandonment of the Ashcroft zinc extraction process, after lengthy trials at Newcastle, New South Wales. The failure of the process is attributed by the inventor to three causes:—(1) diminished metal value of the ore sent for treatment: (2) difficulties due to the accumulation of manganese: (3) lack of the necessary financial support. The failure of the process has obliged the Sulphide Corporation, which purchased the patents, to write £137,500 off its capital account, and has led to much mutual recrimination. Four wet extraction processes are still in operation, but only two of these are working upon a commercial basis. The Hœpfner process is operated at Winnington, in Cheshire, and at Fuerfurth, in Germany; in 1897 1,200 tons zinc were produced by this process at these works. The Dieffenbach process is worked at Duisburg, in Germany, and is stated to be producing about 90 tons zinc monthly. Both of these processes utilise zinc chloride solutions as the electrolyte, and it is questionable whether they would prove profitable in the absence of the chlorine liberated at the anode. The Cowper-Coles extraction process is in experimental operation at Hayle, in Cornwall. It has been described in this paper,* but no figures have been published concerning its efficiency or costs. At Lipine, in Silesia, the Nahnsen process is reported to be still in use.

Many believe that the solution of the problem of zinc recovery from refractory sulphide ores will be solved by a dry or fusion process, a belief shared by the writer; and on this account the Swinburne sulphide ore process, recently described and criticised,† is of exceptional interest. The trials to be made during the present year, with this process, will show whether the expectations formed by its inventor, as regards its practicability and economy are justified. Another fusion process—the Fry process—has emerged from its experimental stage during 1898, and works are now building at Manchester on a very large scale for industrial operation of this process. It is not, however, an electro-metallurgical one, and it is only mentioned because its operation will probably cause a serious fall in the price of zinc, and leave but slight margin for profits to the wet-extraction processes.

In the electro-galvanising industry there is not much to report. The Cowper-Coles process is employed by several firms in this country; the Greenwood process is also in operation. Abroad, the Alexander process and the Richter process are used. There are no figures available from which the output of galvanised iron work by these various firms can be ascertained.

Conclusion.

Limits of space forbid any detailed reference to the remaining electro-chemical and electro-metallurgical industries, but in nearly every case in which electricity has been applied to these smaller manufactures and industries it has proved successful, and the new method *has displaced, or is gradually displacing*, that previously employed.

SPEED VARIATION OF ALTERNATING CURRENT MOTORS.

By W. G. RHODES, M.Sc., M.I.E.E.

One of the objections to the use of alternating current motors is the difficulty of varying their speed under a constant load. For a given frequency of the supply currents, the speed of a synchronous alternating current motor depends only upon the number of its poles, and is quite independent of the load; and the same is true of induction motors, except that in their case there is a slight drop of speed as the load increases.

The above considerations show that the only methods of varying the speed of alternating current motors of any type must be based on either (1) variation of the number of poles possessed by the motor itself, or (2) variation of the frequency of the supply currents. If the former of these methods is adopted, no gradual change in speed is possible since the number of poles can only be altered in sudden steps by means of a suitable switch for rearranging the field (or stator) coils of the motor.

In applying the latter method we are met with the objection that, except in private installations, the frequency of supply is practically constant, and that an auxiliary apparatus is necessary for changing the frequency of supply as desired.

A means of varying the frequency of an alternating current supply has recently been designed and patented by Mr. C. S. Bradley, whose invention consists of a multiphase transformer with either the primary or secondary winding capable of rotation resembling an induction motor in construction. When such a machine is loaded, its secondary rotates at a speed which is less than that of the rotating field by an amount called the "slip," which can be varied by changing the power factor of the circuit which the secondary supplies. This slip is such that the transformer tends to produce electrical resonance in the primary circuit. If the secondary circuit is non-reactive, the secondary of the transformer tends to rotate practically at synchronism, delivering its currents at a very low frequency. By increasing the reactance of the circuit the slip may be increased, and the frequency of the currents delivered increased in proportion. If the secondary circuit of the transformer contains synchronous motors, the variation of slip may be effected by altering their field excitations.

It scarcely seems likely that Mr. Bradley's frequency changer can have a wide application on account of the increased expense which would be incurred to give independent speed variation to any motor on an alternating current circuit.

Undoubtedly an impetus would be given to the use of alternating current motors by the invention of a combined voltage and frequency transformer, more especially if their cost did not preclude their use with individual motors of moderate size.

* Electrical Review, November 25th, 1898.
† Electrical Review, December 16th, 1898.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1899.

Compiled expressly for this journal by **W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham,** *to whom all inquiries should be addressed.*

2. "Improvements in apparatus for connecting electric mains." J. S. Highfield. Dated January 2nd.

8. "An improved electric reversing switch with liquid resistance." W. H. Vaughan and T. Foster. Dated January 2nd.

20. "A new or improved electric heater." T. E. Weaver. Dated January 2nd.

44. "Improvements in apparatus for electrically controlling engines, electric motors, and other machinery." W. H. Harfield. Dated January 2nd.

63. "Improved manufacture of incandescence mantles, filaments, and the like." A. J. Boult. (A. M. Plaissetty, France.) Dated January 2nd.

96. "Improvements in supports for electric conductors." J. M. Andersen and A. Andersen. Dated January 3rd. (*Complete.*)

101. "Electrodes for storage batteries." T. A. Willard. Dated January 3rd. (*Complete.*)

102. "Means for producing battery electrodes." T. A. Willard. Dated January 3rd. (*Complete.*)

108. "Improvements in direct reading electricity meters." J. H. Noad. Dated January 3rd.

132. "Improvements in or in connection with electrical motors for working lifts, cranes, machines, tools, and like stationary machines." R. A. Dawbarn and A. B. Mountain. Dated January 3rd.

133. "Improvements in and in connection with electric railway and tramway propulsion." R. A. Dawbarn and A. B. Mountain. Dated January 3rd.

153. "Improvements in dynamo-electric machines or motors." H. Monnard. Dated January 3rd.

155. "An improved means of sealing enclosed arc electric lamps." A. E. Baines. Dated January 4th.

163. "An automatic switch (for use in conjunction with electric bells that ring continuously when the door of the shop or like place is open)." S. CROWTHER. Dated January 4th.

165. "An improvement of the electrical cord grip lampholder." C. T. BRISCOE and E. JONES. Dated January 4th.

193. "Improvements in telephones." C. J. W. HENSINGER. Dated January 4th.

200. "Improvements in or connected with enclosed arc lamps." G. THOMAS-DAVIES. Dated January 4th.

214. "Improvements in apparatus for electrically interlocking the block and mechanical signals on railways to render it more efficient and certain." L. DE MORAES, G. FERREIRA, and H. J. PRICE. Dated January 4th.

216. "Improvements in electric railways." J. G. LORRAIN. (F. C. Esmond, United States.) Dated January 4th.

218. "Improvements in safety plugs for electric installations." J. MÜHLENTHALER. Dated January 5th.

252. "Means for uniting the filament and leading-in wires of an incandescent electric lamp." J. T. LISTER. Dated January 5th. (*Complete.*)

278. "Improvements in electrically-propelled road vehicles." W. PECK. Dated January 5th. (*Complete.*)

287. "Improvements in cooling appliances for alternating current and rotary phase current motors." SIEMENS BROS. & COMPANY, LIMITED. (Siemens & Halske, Aktengesellschaft, Germany.) Dated January 5th. (*Complete.*)

293. "Improvements in electrical reaction or choking coils." A. E. BAINES. Dated January 6th.

338. "Improved electric arc lamp for portrait photography." G. W. MORGAN. Dated January 6th.

356. "The manufacture of incandescent materials suitable for electric lighting." L. W. GANS. Dated January 6th.

380. "New or improved switches, wall sockets, contact makers, and the like, for use with incandescence electric lamps in which the filament is formed of substances which conduct only at high temperatures to which it is previously heated by a hot shunt." C. A. LEE. Dated January 7th.

405. "Improvements in jacks used in combination with electric annunciators or indicators for the automatic replacement of the shutter or signal flag." A. ECKSTEIN and R. P. EDISFORTH. Dated January 7th.

407. "Improvements in insulated overhead conductors for electrical railways and tramways." E. DUSSEK. Dated January 7th.

416. "Improvements in electrical heaters." A. BARMAN. Dated January 7th.

422. "An improvement in or relating to electric light switches." C. E. CAMPBELL. Dated January 7th.

427. "Improvements in electric igniters for gas engines." W. H. COTTON. Dated January 7th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. THOMPSON & Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, *price, post free,* 9*d.* (*in stamps*).

1897.

19,380. "Improvements in or connected with conduits for electric or cable tramways or railways." W. GRIFFITHS. Dated August 21st, 1897. Conduits for electric or cable railways and tramways are formed of a casing supported on either of the upper edges one-half of the track rail, thus leaving a narrow space for the collector rod. The stay rods are divided, one part engaging with one side of the rail, and the other part engaging with the other side and being secured to a projection on the conduit. The leads are supported from brackets below the flanges of the rail. 5 claims.

19,431. "Improvements in or relating to electric lamps." F. G. W. J. ADAMS. Dated August 12th, 1897. *Incandescent Lamps.*—The bulb of a lamp is surrounded by an outer bulb, enclosing air at a higher or lower pressure than that of the atmosphere, by which a cut-out is held normally closed, so that if the outer bulb is broken the lamp is disconnected. The lamps are especially for use in mines or explosive atmospheres. In the form shown the lamp is supported in the outer bulb by an inner bulb, which is divided by two flexible diaphragms, the space between these communicating with the space in the outer bulb; when this space is exhausted, a wire supported by the diaphragms makes contact with the adjacent leading-in wire. In another form, the diaphragms are replaced by a closed metal tube, closed at its free end, and communicating at the other end with the space in the outer bulb, so that when this is exhausted the tube bends further and makes a connection. A modification is also described. 4 claims.

19,479. "Improved magnetic means for resisting end thrust in shafts or spindles in electric meters and other apparatus." W. STANLEY and F. DARLINGTON. Dated August 23rd, 1897. *Magnetically Relieving Pressure.*—In bearings for the vertical spindles of electric meters, the spindle ends are guided in jewelled bearings. Permanent magnets are arranged with armature pieces embracing the ends of the spindle, which is made with projecting rings at points opposite corresponding rings inside the armature pieces. The magnetic flux thus passes nearly symmetrically along the spindle and ends to hold it in position, resisting vertically-disturbing forces. The arrangement is suitable for a wattmeter, the magnets exerting a braking action upon the disc. If a braking action is not required, the magnets are made in horse-shoe form extending beyond the circumference of the disc. 7 claims.

19,512. "Improvements in means for manufacturing carbides." J. W. KENEVEL, C. A. SPOFFORD and J. H. MEAD. Dated August 24th, 1897. Relates to a furnace for making carbides. The powdered material, such as a mixture of two parts of lime to one of carbon, is fed from a hopper, by a regulating slide, between rotating cylindrical electrodes. Kerosene is applied to the electrodes by tubes from a reservoir, to prevent adhesion to them of the carbide. Below the electrodes the carbide falls on baffles. The shafts of the electrodes are carried in sliding bearings, pressed inwards by springs, and are connected by gear wheels supported by links. The electrodes may be carbon cylinders, or carbon discs, separated by glass, mica, or other discs, or carbon rods, inserted in radial holes in fireclay cylinders; these parts are carried by conducting sleeves on glass tubes surrounding the shafts, and the current is conveyed to them by brushes and rings. 10 claims.

19,518. "Improvements in electric arc lamps." T. SPENCER. Dated July 17th, 1897. An alternating current lamp having enclosed carbons, not cored, is provided with a choking coil in series with the carbons, the core of the choking coil being automatically adjusted in opposition to weight, or a spring to regulate the current in accordance with the difference of potential of the carbons. In the form shown, the choking coil is also the regulating coil of the lamp, its core being connected by a clutch or other feeding mechanism with the upper carbon holder. If the arc becomes long, the current diminishing allows the core to drop, thus lowering the upper carbon and reducing the self-induction of the coil. The coil is enclosed in laminating iron. In another arrangement, both carbons are stationary, and the current is regulated only by passage through the inductive coil, the core of which is drawn down by a weight or spring. 1 claim.

19,638. "Improvements in and connected with electrical storage batteries and plates therefor." R. KENNEDY. Dated October 11th, 1897. The plates are built up of a central plate of lead, which has been cleaned with dilute nitric acid, and coated on one side with a paste of litharge and sulphuric acid, and on the other side with a paste of red lead and sulphuric acid. To one side of this plate are secured perforated plates coated with litharge, and to the other similar plates coated with red lead, so that a plate is formed which, in the battery, is positive on one side and negative on the other. The perforated plates may be flat or corrugated, and the central lead plate may be dispensed with. A number of such plates made up into a battery and separated by rubber washers and diaphragms, the latter of which are perforated to within half an inch of the lower edge. The end plates are coated only with litharge and red lead respectively. The plates are held between insulating pieces through which pass the terminals. 6 claims.

20,145. "Improvements in accumulator plates." A. LEHMANN and A. MANN. Dated September 1st, 1897. Relates to plates or electrodes. The plate consists of a zig-zag metal core, on which is formed a series of triangular flaps, those on opposite sides not being in the same horizontal plane. A modification is shown, in which the core piece is straight and the flaps are rectangular in shape. 3 claims.

20,316. "Improvements in electric fire engines." G. C. DYMOND. (G. W. Cox and E. E. Smull.) Dated September 3rd, 1897. Relates to a fire engine in which the pump is driven by an electro-motor which may also be used for propelling the vehicle itself. In one form of the engine described, the water is propelled by a rotary pump driven by an electro-motor. The electric current is taken from a public supply by leads which are furnished with a cut-out switch. Beneath the pump is a water tank to contain a reserve supply to be used before the engine is connected to a hydrant by a hose pipe. When it is desired to draw from the tank, a cock is closed and a cock is opened, which connects the pump to the tank through a branch pipe. The tank may be filled by the pump by opening a branch pipe leading to the cistern from the discharge side of the pump. When the vehicle is propelled by electricity, the electro-motor is connected to the wheels of the vehicle by bevel gearing and pitch chains, and the current is derived from a storage battery. The gearing can be disengaged by a handle near the driver. A hose reel may be hooked on behind the fire engine. 7 claims.

1898.

12,827. "Improvements in electric primary and secondary batteries." N. JEANLY. Dated May 24th, 1898. Relates to improvements in electric primary and secondary batteries. The main feature of the latter is that its exciting liquid is, chemically speaking, kept separate from the depolarising liquid, although electrically, the electrodes are directly connected, while as regards the relative quantities of the liquids contained in the cells, constant and uniform proportions are maintained. The negative electrode is formed of parallel wires secured to a cross bar serving as a collector, and the positive formed of laminæ of zinc secured to a transverse rod similar to the collector. The wires, rods, or the like are placed at the bottoms of baths; such baths being of elongated shape, narrow and low, and communicating below, each at one end through an orifice with a feeding reservoir to which the said baths are properly fitted. The baths and reservoir forming jointly a connected whole are constructed of India-rubber. The negative collector is secured to the receiver which has a false bottom situated a little distance below the upper edge of the baths. The whole arrangement is placed in a suitable receiver. Acidulated water is distributed to the baths until the baths and the receivers are completely filled. Crystals of sulphate of copper placed upon the false bottom dissolve and form the depolarising liquid. 7 claims.